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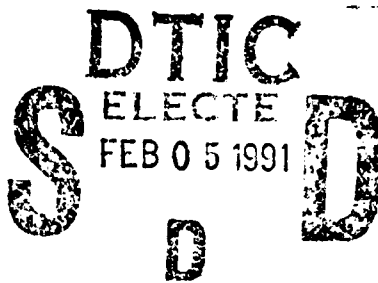
The Optimization of Simulation-Based Training Systems: Model Data Collection and Utilization

**Ruth P. Willis, Probin Guha,
and David R. Hunter**

Eagle Technology, Inc.

Michael J. Singer

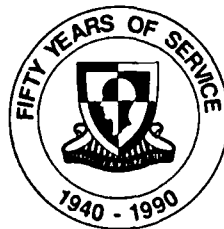
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**PM TRADE Field Unit at Orlando, Florida
Stephen Goldberg, Chief**

**Training Research Laboratory
Jack H. Hiller, Director**

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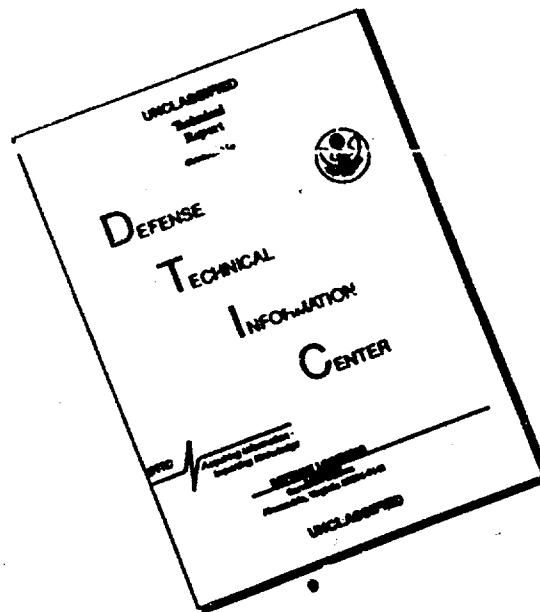
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19. ABSTRACT (Continue on reverse if necessary and identify by block number) ✓ The goals of this effort were (1) to develop a method for collecting necessary internal, resident data and constructing rules for Optimization of Simulation-Based Training Systems (OSBATS) models; (2) to specify and develop a system for managing the data elements and for- mats for the resident database; and (3) to collect, convert, and enter data and rules in the recommended database system as a prototype demonstration. The data collection method that was developed centered on interviews and survey questionnaires that could be used to acquire the detailed information needed by the OSBATS models. A prototype database to contain the necessary information was constructed and loaded with the existing and newly gathered information. Researchers concluded that the information could be collected with great effort, and stored in a database for use by the models. Several problems in the separate implementation of decision aid (OSBATS) and database were identified. The use of survey information for rule construction was illustrated, and the potential for expanding OSBATS was presented.				
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THE OPTIMIZATION OF SIMULATION-BASED TRAINING SYSTEMS: MODEL DATA COLLECTION AND UTILIZATION

EXECUTIVE SUMMARY

Requirement:

The basic goals of this effort were to (1) develop a data collection methodology for the collection of necessary internal, resident data and the construction of rules for the Optimization models; (2) specify and develop a prototype database management system(s) for handling the data elements and formats necessary for the resident database and rules for the Optimization models; and (3) collect, convert, and enter required data and rules in the recommended database system as a prototype demonstration.

Procedure:

The status of the models for the Optimization of Simulation-Based Training Systems (OSBATS) was determined and used as a guide for data and information requirements. Several interviews were conducted with subject matter experts, and many of the training devices at Fort Rucker were examined for use in the program. A training device capability survey and a task survey were developed to collect resident data on two training devices. The surveys were completed by the appropriate instructors at Fort Rucker. A cost estimating relationship was identified and used to generate the resident cost data required by the model. The resident data were entered into the Database Management System (DBMS) and demonstrated.

Findings:

One major finding was that there is a need for adequate taxonomies for applying and relating data within and across training domains. This data collection effort was forced to rely on expert opinion because current training system research provided neither the level of detail nor the task information required by the model. During the surveys, other enlightening difficulties were discovered: that for some training devices there are no lists of tasks trained on that device, that many instructors are unfamiliar with instructional support features on the training devices they use, and that the structure of the OSBATS models led to difficulties in collecting and structuring information. In addition, because of the evolving nature of the OSBATS models, there was a need to develop a buffer between the

OSBATS and the DBMS. The resulting data exchange interface allowed the OSBATS model and the DBMS to develop independently. This pointed out several problems associated with independent development of models and databases.

Utilization of Findings:

This report may be used by researchers for the development of expert system rules and for guidance in collecting training device data on tasks, costs, and utilization patterns. It is primarily a guide for continuing work in the rather narrow area of developing aids for conducting tradeoff determinations associated with the design of training device concepts.

THE OPTIMIZATION OF SIMULATION-BASED TRAINING SYSTEMS: MODEL
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THE OPTIMIZATION OF SIMULATION-BASED TRAINING SYSTEMS:
MODEL DATA COLLECTION AND UTILIZATION

Introduction

The development of a training system is a complex undertaking that should use behavioral learning principles to convey domain-specific skills and knowledges. Military training systems often incorporate training devices that can be more complex than the actual equipment itself. A fair amount is known about how training systems or programs should be designed and implemented, with less information on what the varied tradeoffs actually mean in terms of performance, training effectiveness, and overall cost. Most of what is known is applied within a systems approach to training, typified by Instructional Systems Development (ISD) procedures (Branson, Rayner, Cox, Furman, King, & Hannum, 1975).

Within this arena is the "smaller" problem of designing a training system strategy that makes effective use of training devices. Guidelines exist for developing the requirements for training devices, and these guidelines generally include objectives for integrating training media in training programs (Heeringa, Baum, Holman & Peio, 1982). Although there is a considerable amount of data about specific training devices as used within specific training systems, there is no organized body of information that can be used to guide the design of effective training device based systems or segments (Hays and Singer, 1983). There is also an increasingly large number of technological choices that can be used to address any single training problem. As a result, the design and use of effective training devices has become an effort based on imperfect data and opinion-based design rules.

In an effort to improve this situation, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) and the Project Manager for Training Devices (PM Trade) have embarked on a research and development program that addresses this problem in training-device design. This program is an attempt to prescribe training device configurations based on training technology and learning theory currently available. The program has developed a theoretical model for aiding training device designers in developing training device alternatives. The prototype implementation of this model, called the Optimization of Simulation-Based Training Systems (OSBATS), provides tools for selecting features and performing tradeoff analyses of training device configuration concepts (Sticha, Blacksten, Buede, Singer, Gilligan, Mumaw, & Morrison, 1988).

The primary goal of the effort documented here was to provide information for expanding OSBATS through collecting needed model data. In order to do this the existing OSBATS model data had to be analyzed and a prototype database structured. The effort also required a) that sources of data be identified; b) methods of data collection developed, tested and used; and c) the information be correctly structured and entered into the

database. Since the OSBATS model was developed to deal explicitly within the domain of training advanced rotary-wing operations, that was the context for this effort. Implicitly the whole effort was a test; allowing an evaluation of needed methods, level of difficulty, and overall supportability of OSBATS. In order to understand what was required, what was done, what was accomplished, as well as the relevance and importance of the conclusions, a brief review of OSBATS is required.

Optimization of Simulation-Based Training Systems

The OSBATS prototype is a prototype computer-based decision support system that can aid training-device designers and engineers in specifying the optimal use of training resources in the design of simulation-based training systems (Sticha, et.al., 1988). As with all decision support systems (Sprague & Watson, 1977), OSBATS is composed of three basic subsystems: the user interface, the data that the system uses, and the decision models that use the data to recommend designs. These three subsystems for OSBATS are briefly discussed below.

The user interface serves as the basis for user confidence and understanding in the system processes and recommendations. The OSBATS system is intended for use by engineering and educational professionals involved in training device concept formulation efforts. The system uses graphs and tables to present results of the tradeoff analyses performed and the information used in making the analyses. The primary means of directing the system is through using a mouse to make menu selections, with the rest of the entries made through standard keyboard input.

The data subsystem required for decision aids usually consists of a database of information. It may also include procedures for collecting, organizing, and entering data; and possibly an inquiry or retrieval system for accessing the data. One major purpose of this work effort has been to prototype and demonstrate an appropriate database system that will support the OSBATS models. There are two general types of data required to support the functioning of the model tools. The first type of data, called resident or internal data, covers the unchanging or infrequently changing information and relational rules involved in the generation of options, tradeoffs, and configurations. As will be discussed later, not all of these data are currently available to the designers or engineers. The second type of data is situationally specific task and training program data, which is used during discrete sessions.

The decision models, the central tools within OSBATS, provide recommendations on instructional features and levels of prescribed fidelity dimensions, as well as analyzing mixtures of device use in the training system. The goal of the system is to

develop a training device configuration that has the greatest benefit for the projected cost. The benefits can be experimentally based with reference to training literature, can use estimates provided by experts, or some mixture of sources (the most likely situation). The costs used include the investment and operating cost of the training device over its life cycle. The OSBATS model was developed as a framework that allows the addition and insertion of new models for different aspects of the concept formulation process.

OSBATS Models

The modeling tools were developed by taking a theoretically based, top-down analytical approach (Sticha, Singer, Blacksten, Mumaw, & Buede, 1987). The two major variables used to make the design decisions are training effectiveness and cost. Training effectiveness is typically measured by how well the student performs following completion of training. The system works from assumptions about training transfer from training devices to actual equipment, and training transfer between training devices. These assumptions are based on task cue and response needs, where transfer is assumed to be a function of the fidelity level required by the task.

The central problem addressed is the tradeoff between providing the required level of fidelity versus the cost of that level of fidelity, hence the central model in OSBATS is a tool for fidelity optimization (Singer & Sticha, 1987). The training effectiveness of a device is also influenced by the instructional strategy used, and instructional features can have a significant effect on the cost of the training device, which led to the inclusion of an instructional features tool in OSBATS. The approach used by the fidelity optimization and instructional features modules work best when the tasks form a coherent cluster of simulation needs. This led to the Simulation Configuration tool, which clusters tasks in terms of simulation requirements and fidelity based cost estimates.

The problem of coherent training device design has another major factor, separate from instructional considerations. The cost of developing and using a family of training devices must be considered in order to be efficient in using training resources. The concept formulation process must ensure that the minimum family of devices for the tasks are developed, and the Training Device Selection and Resource Allocation tools serve this purpose. Time in training programs is also limited, and constraints are imposed by student flow. These factors and the training plan help determine the numbers of training devices required, which in turn effects training program resources. The Resource Allocation tool estimates the number of devices needed

to meet requirements, working to derive the optimal family of training devices for the tasks, training resources, and student flow.

Data Requirements

In order to use training effectiveness and training cost variables in the device-design calculations, the OSBATS model requires data from a variety of areas. This section describes the data and the format required by the model, and discusses the sources and format for the data as proposed by the model developers (Sticha, Singer, Blacksten, Mumaw, & Buede, 1987) and analyzed during a preliminary design effort (Stults & Guha, 1987).

The resident or internal data cover general task characteristic based rules for fidelity options, types of instructional features, fidelity and instructional feature cost estimates, learning parameters, and so forth. The presumption was that the data and rules would be developed through analytical evaluations and data collection efforts, including experiments and surveys designed to verify certain assumptions and help determine the hypothesized task characteristic and feature relationships within the model. The resident data include rules about the relationships between the resident data values and the input data. At present these rules are embedded in an expert system shell.

The situationally specific or input data are used to initiate execution of the models. These data include descriptions of the tasks to be taught, the task performance criteria to be met by the training, the current training investment and operating cost projection, the type of instructional approach, number of students, number of instructors, descriptions of current devices or equipment, and the time for training each task. The assumption was that these data should come from the analysis of training requirements conducted during the development of the program of instruction.

Task Data. The data elements required for the OSBATS tools were organized by the model developers into six categories. Table 1 identifies which data elements are used in each of the OSBATS tools identified in the previous section. The following sections describe the major categories of data used by the model

1. Task Training Requirements. The data elements included in this group provide information to the model about the training performance requirements associated with tasks.

Table 1. Data Elements by Model

<u>Cat</u>	<u>Description</u>	<u>SC</u>	<u>IFS</u>	<u>FO</u>	<u>TDS</u>	<u>RA</u>
1	Task Training Requirement	X	X	X	X	X
1A	Task Learning Points	X	X		X	X
1A1	Entry Performance Level	X	X		X	X
1A2	Performance Standard	X	X		X	X
1B	Task Simulation Evaluation Factors	X				
1B1	Absolute Requirement	X				
1B2	Special Weather	X				
1B3	Special Situation	X				
1B4	Special Equipment	X				
1B5	Training Effectiveness Enhancements	X				
1C	Task Cue & Response Requirements		X		X	X
1C1	Visual Resolution	X		X	X	X
1C2	Visual Content	X		X	X	X
1C3	Visual Texture	X		X	X	X
1C4	Front Visual Field of View (FOV)	X		X	X	X
1C5	Side Visual FOV	X		X	X	X
1C6	Point Special Effects	X		X	X	X
1C7	Area Special	X		X	X	X
1C8	Platform Motion	X		X	X	X
1C9	Seat Motion	X		X	X	X
1C10	Sound Special Effects	X		X	X	X
1C11	Map Area	X		X	X	X
2	Other Task Data	X	X	X	X	X
2A	Task Training Hours and Costs	X	X	X	X	X
2A1	Classroom Hours	X	X	X	X	X
2A2	Actual Equip. Non-Operational Hours	X	X	X	X	X
2A3	Actual Equipment Operational Hours	X	X	X	X	X
2A4	Actual Equipment Setup Hours	X	X	X	X	X
2A5	Other Training Costs	X	X	X	X	X
2B	Task Info Processing Characteristics	X	X		X	X
2B1	Continuous Movement	X	X		X	X
2B2	Procedural	X	X		X	X
2B3	Perception	X	X		X	X
2B4	Decision Making/Rule Using	X	X		X	X
2B5	Verbal Information	X	X		X	X
2B6	Voice Communication	X	X		X	X
2B7	More Than Seven Steps	X	X		X	X
2B8	Time Sharing	X	X		X	X
2B9	Computer-Detectable Responses	X	X		X	X
2B10	Meaningful Performance Tolerances	X	X		X	X
2B11	Intrinsic Feedback	X	X		X	X
2B12	Cue Salience	X	X		X	X

OSBATS Models

RA Resource Allocation TDS Training Device Selection
FO Fidelity Optimization IFS Instructional Feature Selection
SC Simulation Configuration

Table 1. Data Elements by Model

<u>Cat</u>	<u>Description</u>	<u>SC</u>	<u>IFS</u>	<u>FO</u>	<u>TDS</u>	<u>RA</u>
2B13	Crash Probability	x	x		x	x
2B14	Situational Awareness	x	x		x	x
3	Training Device Data	x	x	x	x	x
3A	Training Device Costs	x	x	x	x	x
3A1	Investment Cost	x	x	x	x	x
3A2	Annual Fixed Operating Cost	x	x	x	x	x
3A3	Hourly Variable Operating Cost	x	x	x	x	x
3A4	Maximum Annual Utilization	x	x	x	x	x
3B	Training Device Cue & Response Capabilities	x			x	x
3B1	Visual Resolution	x			x	x
3B2	Visual Content	x			x	x
3B3	Visual Texture	x			x	x
3B4	Front Visual Field Of View (FOV)	x			x	x
3B5	Side Visual FOV	x			x	x
3B6	Point Special Effects	x			x	x
3B7	Area Special Effects	x			x	x
3B8	Platform Motion	x			x	x
3B9	Seat Motion	x			x	x
3B10	Sound Special Effects	x			x	x
3B11	Map Area	x			x	x
3C	Training Device Instructional Features	x			x	x
3C1	Tutorial	x			x	x
3C2	Scenario Control	x			x	x
3C3	Initial Conditions	x			x	x
3C4	Real Time Variables Control	x			x	x
3C5	Malfunction Insertion	x			x	x
3C6	IOS Display	x			x	x
3C7	Procedures Monitoring	x			x	x
3C8	System Freeze	x			x	x
3C9	Parameter Freeze	x			x	x
3C10	Record/Replay	x			x	x
3C11	Performance Measurement	x			x	x
3C12	Hard Copy	x			x	x
3C13	Remote Replay	x			x	x
3C14	Data Analysis	x			x	x
4	Fidelity Dimension Data	x		x	x	x
4A	Fidelity Dimensions and Levels	x		x		
4A1	Technical Performance levels	x		x		

OSBATS Models

RA Resource Allocation TDS Training Device Selection
FO Fidelity Optimization IFS Instructional Feature Selection
SC Simulation Configuration

Table 1. Data Elements by Model

<u>Cat</u>	<u>Description</u>	<u>SC</u>	<u>IFS</u>	<u>FO</u>	<u>TDS</u>	<u>RA</u>
4B	Fidelity Dimension Cost Data	X		X		
4B1	Minimum Cost	X		X		
4B2	Maximum Cost	X		X		
4B3	Exponent	X		X		
4C	Minimum Performance Parameter	X			X	X
5	Instructional Feature Data	X	X		X	X
5A	Instructional Feature Rules	X	X		X	X
5A1	Rule Conditions	X	X		X	X
5A2	Implied Instructional Features	X	X		X	X
5B	Instructional Features Cost and Weight		X			
5B1	Instructional Feature Cost		X			
5B2	Instructional Feature Benefit Weight		X			
6	Training System Data	X			X	X
6A	Course and System Information	X			X	X
6A1	Annual Student Throughout	X			X	X
6B	Model Information	X			X	X
6B1	Standard Adjustment Rate	X			X	X
6B2	Learning Curve Exponent	X			X	X
6B3	Maximum Instructional Feature Effect	X			X	X
6B4	Maximum Number of Instructional Features		X			
6B5	Assumed Setup Savings percentage	X			X	X
6B6	Cost Savings Weight	X			X	X
6B7	Recommendation Boundaries	X				
6B8	Currently Assumed utilization				X	

OSBATS Models

RA Resource Allocation TDS Training Device Selection
FO Fidelity Optimization IFS Instructional Feature Selection
SC Simulation Configuration

1A. Task Learning Points. These data describe student entry performance level and performance standard for each task on a scale that ranges from no knowledge to expert performance levels.

1B. Task Simulation Evaluation Factors. These data include an assessment of each task on the need for simulation, including safety concerns, special performance conditions, and anticipated training effects.

1C. Task Cue and Response Requirements. These data describe the environment required to perform the task at the required level of proficiency. This information is used by the rule systems to specify applicable features for task training.

2. Other Task Data. The information required here include task training hours and task information processing characteristics.

2A. Task Training Hours and Costs. These data elements describe estimates of the training time and costs involved in meeting the training requirements for each task without a training device, through the use of the actual equipment.

2B. Task Information Processing Characteristics. These data elements represent task ratings on a checklist of information-processing activities, such as timesharing or continuous-control processes, that are relevant to the evaluation of training-device instructional feature needs.

3. Training-Device Data. These data describe training media in terms of device costs, fidelity dimensions, and instructional features.

3A. Training-Device Costs. These data elements include the investment cost, fixed annual operation cost, variable hourly operation cost, maximum annual hours of utilization, and years expected in the life cycle for the training device.

3B. Training-Device Cue and Response Capabilities. These data assign the technical performance values for training devices on the fidelity dimensions.

3C. Training-Device Instructional Features. The data identify instructional features which might be available on the training device.

4. Fidelity Dimension Data. This category of data defines the technical performance scale for the fidelity dimensions in terms of concrete examples, and contains parameters for estimating training-device costs as a function of cue and response capabilities.

4A. Fidelity Dimensions and Levels. These data define each fidelity dimension and list the levels and the associated technical performance rating on a scale from 0 to 1.0.

4B. Fidelity Dimension Cost Data. This class of data includes the three parameters for the function that is used to estimate the cost of a particular level from its technical performance, the minimum cost, maximum cost, and an exponent that describes the shape of the cost curve for the dimension.

5. Instructional Feature Data. This class of data describes the costs and benefits of the instructional features and gives specific rules for associating instructional features to tasks.

5A. Instructional Feature Rules. Instructional feature rules specify the conditions under which each instructional feature would improve training efficiency.

5B. Instructional Feature Cost and Weight. These data elements include an assessment of the development cost of each instructional feature and an assessed weight that moderates the calculated benefit values for instructional features.

6. Training System Data. This class of data includes a collection of miscellaneous data and general information about the training course.

6A. Course and System Information. This is a single element describing the required number of graduates per year.

6B. Model Information. This category of data includes a variety of assumed parameters used by the model. For example, the number of instructional features to be used in the device, and assumptions about the training-device utilization.

Data Sources. Several sources of data were proposed by the developers of the OSBATS' tools (Sticha, Blacksten, Buede, & Cross, 1986) to meet the model requirements. These sources of information included subject-matter experts, training-system experts, training researchers, model developers, and model users. Table 2 displays the proposed sources of data for each of the OSBATS data elements. The five major categories are defined below.

Subject-matter experts included instructors, training developers, and expert job performers. They were proposed as sources of task information because of their knowledge of the tasks being trained.

Training-system experts are the developers from the school where the to-be-trained tasks, or similar tasks, are already being trained. They were proposed to provide training device data, fidelity dimension data, and instructional feature cost data because of their familiarity with the training devices.

Training researchers are professionals engaged in conducting research in training program variables. They were proposed as the major source of instructional-feature and fidelity rules.

Table 2. Data Element Format and Source

<u>Cat</u>	<u>Data Elements</u>	<u>Format</u>	<u>Source</u>
1	Task Training Requirement		
1A	Task Learning Points		
1A1	Entry Performance Level	0-1.0	SME
1A2	Performance Standard	0-1.0	SME
1B	Task Simulation Evaluation Factors		
1B1	Absolute Requirement	0,1	SME,MU
1B2	Special Weather	0,1	SME,MU
1B3	Special Situation	0,1	SME,MU
1B4	Special Equipment	0,1	SME,MU
1B5	Training Effect Enhancements	0,1	SME,MU
1C	Task Cue & Response Requirements		
1C1	Visual Resolution	0-1.0	SME,TR
1C2	Visual Content	0-1.0	SME,TR
1C3	Visual Texture	0-1.0	SME,TR
1C4	Front Visual Field of View (FOV)	0-1.0	SME,TR
1C5	Side Visual FOV	0-1.0	SME,TR
1C6	Point Special Effects	0-1.0	SME,TR
1C7	Area Special	0-1.0	SME,TR
1C8	Platform Motion	0-1.0	SME,TR
1C9	Seat Motion	0-1.0	SME,TR
1C10	Sound Special Effects	0-1.0	SME,TR
1C11	Map Area	0-1.0	SME,TR
2	Other Task Data		
2A	Task Training Hours and Costs		
2A1	Classroom Hours	hours	SME
2A2	Actual Equip. Non-Op. Hours	hours	SME
2A3	Actual Equipment Op. Hours	hours	SME
2A4	Actual Equipment Setup Hours	hours	SME
2A5	Other Training Costs	\$	SME
2B	Task Info Processing Characteristics		
2B1	Continuous Movement	0,1	SME,TR
2B2	Procedural	0,1	SME,TR
2B3	Perception	0,1	SME,TR
2B4	Decision Making/Rule Using	0,1	SME,TR
2B5	Verbal Information	0,1	SME,TR
2B6	Voice Communication	0,1	SME,TR
2B7	More Than Seven Steps	0,1	SME,TR
2B8	Time Sharing	0,1	SME,TR
2B9	Computer-Detectable Responses	0,1	SME,TR
2B10	Meaningful Performance Tolerances	0,1	SME,TR
2B11	Intrinsic Feedback	0,1	SME,TR
2B12	Cue Salience	0,1	SME,TR
2B13	Crash Probability	0,1	SME,TR
2B14	Situational Awareness	0,1	SME,TR

SME Subject Matter Expert
TSE Training System Expert
MD Model Developer

TR Training Researchers
MU Model User

Table 2. Data Element Format and Source

<u>Cat</u>	<u>Data Elements</u>	<u>Format</u>	<u>Source</u>
3	Training Device Data		
3A	Training Device Costs		
3A1	Investment Cost	\$	TSE
3A2	Annual Fixed Operating Cost	\$	TSE
3A3	Hourly Variable Operating Cost	\$	TSE
3A4	Lifecycle	years	TSE, MU
3A5	Maximum Annual Utilization	hours	TSE, MU
3B	Training Device Cue & Response Capabilities		
3B1	Visual Resolution	0-1.0	TSE
3B2	Visual Content	0-1.0	TSE
3B3	Visual Texture	0-1.0	TSE
3B4	Front Visual Field Of View (FOV)	0-1.0	TSE
3B5	Side Visual FOV	0-1.0	TSE
3B6	Point Special Effects	0-1.0	TSE
3B7	Area Special Effects	0-1.0	TSE
3B8	Platform Motion	0-1.0	TSE
3B9	Seat Motion	0-1.0	TSE
3B10	Sound Special Effects	0-1.0	TSE
3B11	Map Area	0-1.0	TSE
3C	Training Device Instructional Features		
3C1	Tutorial	0,1	TSE
3C2	Scenario Control	0,1	TSE
3C3	Initial Conditions	0,1	TSE
3C4	Real Time Variables Control	0,1	TSE
3C5	Malfunction Insertion	0,1	TSE
3C6	IOS Display	0,1	TSE
3C7	Procedures Monitoring	0,1	TSE
3C8	System Freeze	0,1	TSE
3C9	Parameter Freeze	0,1	TSE
3C10	Record/Replay	0,1	TSE
3C11	Performance Measurement	0,1	TSE
3C12	Hard Copy	0,1	TSE
3C13	Remote Replay	0,1	TSE
3C14	Data Analysis	0,1	TSE
4	Fidelity Dimension Data		
4A	Fidelity Dimensions and Levels		
4A1	Technical Performance levels	0-1.0	MD, TSE, SME
4B	Fidelity Dimension Cost Data		
4B1	Minimum Cost	\$	TSE, MD
4B2	Maximum Cost	\$	TSE, MD
4B3	Exponent	>0	TSE, MD
4C	Minimum Performance Parameter	0-1.0	TR, TSE, SME

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Table 2. Data Element Format and Source

<u>Cat</u>	<u>Data Elements</u>	<u>Format</u>	<u>Source</u>
5	Instructional Feature Data		
5A	Instructional Feature Rules		
5A1	Rule Conditions	Variable	TR
5A2	Implied Instructional Features	Variable	TR
5B	Instructional Features Cost and Weight		
5B1	Inst. Feature Cost	\$	TSE
5B2	Inst. Feature Benefit Weight	0-1.0	TR, SME
6	Training System Data		
6A	Course and System Information		
6A1	Annual Student Throughout	grads/yr	SME, MU
6B	Model Information		
6B1	Standard Adjustment Rate	%	TR, MD
6B2	Learning Curve Exponent	>0	TR, MD
6B3	Max. Instructional Feature Effect	%	TR, MD
6B4	Maximum Number of Inst. Features	1, 2, 3, ...	TR, MD
6B5	Assumed Setup Savings percentage	%	TR, MD
6B6	Cost Savings Weight	0-1.0	MU
6B7	Recommendation Boundaries	0-1.0	MU
6B8	Currently Assumed Utilization	hours/yr	MD

The model developers are the professionals that developed the OSBATS model. They were required to structure the relationship between variables to reduce interaction effects. This structuring was accomplished by setting variables in the OSBATS model, such as the learning rate parameter.

The model user is the professional that is using the model to conduct tradeoff analyses and produce training device concepts. They can make value judgments which adjust the results of the analysis to account for factors that are not included in the model but which the user feels are important. These judgments are currently implemented by using or not using certain preset weighting factors.

The model developers proposed that as the model evolved the nature of the data required would also change, in that subject matter experts and training system experts would provide more factual information about the tasks trained. A step in this direction has been made. In the original version of OSBATS, direct choices about the task training requirement parameters were required. The current research version of OSBATS uses expert system rules that elicit the task training requirements for the different tasks. The task cue and response issues to which the subject matter expert addresses are listed in Table 3.

Table 3. Data Elements For Task Training Requirements

1C. TASK CUE & RESPONSE REQUIREMENTS

1. Out-of-Cockpit Visual Requirement
 - a. Task Performance Judgments
 - b. Number of Altitudes
 - c. Altitude Estimation
 - d. Altimeter Required
 - e. Altitude Estimation Through Cues
 - f. Altitude Tolerance
 - g. Maximum Distance to Cues
 - h. Slant Range Judgment
 - i. Slant Range Judgments Through Objects
 - j. Maximum Slant Range to Objects
 - k. Slant Range Tolerance
 - l. "Other Object" Minimum Size
 - m. Clearance Judgment
 - n. Object Detection
 - o. Maximum Distance to Objects
 - p. Minimal Scene Content
 - q. Database Size
 - r. Task Performance Environment
 - s. Front Field of View
 - t. Side Field of View
 - u. Scene Content Elements
2. Motion
 - a. Cue Magnitude
 - b. Correlated Motion Cues
 - c. Emergency Procedure
 - d. Motion Cue for Emergency Procedure Initiation
 - e. Continuous Movement
3. Audio Signals
 - a. Correlated Engine Noise
 - b. Noise Cue for Emergency Procedure Initiation

2B. TASK INFORMATION PROCESSING CHARACTERISTICS

1. Type of Activity
2. Computer-detectable Responses
3. Intrinsic Feedback
4. Crash Probability
5. Cue Salience
6. Situational Awareness
7. Number of Steps
8. Time Sharing
9. Instructor Role
10. Meaningful Performance Tolerance

Data Collection

This section documents the steps taken and lessons learned in working to collect data for OSBATS. This collection effort has been guided by a guiding premise established during OSBATS development, that training needs and training goals have been previously established. The effort was not intended to evaluate or establish training needs and goals within existing courses for selecting training devices. The purpose of this effort was to document the fidelity dimensions and instructional features currently in use on domain appropriate Army training devices, and to gather cost data for these devices and features.

The resident data include training device data, fidelity dimension information, and instructional features information. As mentioned previously, one goal of this effort was to expand the breadth of the OSBATS prototype by collecting more structured resident model information than was available from the prototype effort. Another goal is to use that experience to determine the difficulty of expanding the models applicability and provide some guidance for future efforts.

The specific objectives of this effort were to prepare a methodology for the collection of the internal, resident data required by the model and required for the construction of expert system rules; to specify and prototype the database management system necessary to handle the data elements for the resident database and rules; and to demonstrate the database management system with data collected using the methodology.

The effort built upon the previously developed guideline information identifying data sources and methods for generating the rule set (Sticha, et. al., 1988). In addition, a previous contractual effort by Engineering and Economics Research Systems (1987) had developed a prototype Data Acquisition Form for collecting and recording the resident data which was updated for our use (Appendix A), as well as an example on-line Data Dictionary (Appendix B) which could be accessed through a DataBase Management System. The data dictionary defined the data elements required by that earlier version of the OSBATS models, indicated how they were measured, suggested where information about that element could be found, and finally listed the elements composing the factors.

Resident Data

A review of the resident data required to exercise the version of the OSBATS model delivered in September 1987 indicated there were three classes of data to be collected: Fidelity Dimensions and levels on specific Training Devices; Instructional Features available on the devices; and device development, operation, and maintenance Costs.

Fidelity Dimensions

Visual Resolution. This dimension is defined as the maximum distance on the student pilot's visual display at which an object one meter square can be discriminated from the background. Visual resolution is measured using a 6-point scale. The distance is thus used to assign a level to the visual resolution needed by the training device. The rule used in classifying the fidelity levels is as follows.

If an object one meter square is visible at:

- 3/10 km, then visual resolution is at level "1"
- 1/2 km, level "2"
- 1 km, level "3"
- 2 km, level "4"
- 3 km, level "5"
- 4 km, level "6".

Visual Content. This refers to those background elements of the visual display such as terrain, cultural features and 3-D objects. Visual content is assigned using examples which have been determined by the model developers. The rule used in classifying the fidelity levels is as follows.

If the visual content contains:

- Ground plane with a few trees, then assign level "1"
- Ground plane, trees and terrain relief features, level "2"
- Ground plane, terrain relief plus realistic configuration of trees, level "3"
- Ground plane, terrain relief, realistic configuration of trees plus low density hydrographic and cultural features, level "4"
- Ground plane, terrain relief, realistic configuration of trees, plus medium density hydrographic and cultural features, level "5"
- Ground plane, terrain relief, realistic configuration of trees, plus high density hydrographic and cultural features, level "6".

Visual Texture. This represents the method used to "fill" the scene to enhance the realism of the scene content. Visual texture is measured using descriptive examples which have been established by the model developers. The rule used in classifying the fidelity levels looks like the following.

If visual texture is generated by:

- Basic scene-construction elements (lines, polygons), then visual texture is at level "1"
- Modulating functions within basic scene-construction elements, level "2"

Digitized photographs (small inventory) to fill basic scene-construction elements, level "3"
Digitized photographs (medium inventory) to fill basic scene-construction elements, level "4"
Digitized photographs (large inventory) to fill basic scene-construction elements, level "5".

Front Visual Field of View. This refers to the area visible to the student pilot through the front cockpit display window. Front visual field of view is measured using a 3-point scale that places field of view along a size continuum. The rule used in classifying the fidelity levels is as follows.

If the cockpit display's front field of view is:

40 degrees vertical by 40 degrees horizontal, then front field of view is at level "1"
40 degrees vertical by 50 degrees horizontal, level "2"
40 degrees vertical by 60 degrees horizontal, level "3".

Side Visual Field of View. This refers to the area visible to the student pilot through a side cockpit display window. Side visual field of view is measured using a 7-point scale that places field of view along a size continuum. The rule used in classifying the fidelity levels takes the following form.

If the cockpit display's side field of view is:

Left side window of 40 degrees vertical by 40 degrees horizontal, then side field of view is at level "1"
Left side window of 40 degrees vertical by 50 degrees horizontal, level "2"
Left side window of 50 degrees vertical by 50 degrees horizontal, level "3"
Left side window of 50 degrees vertical by 60 degrees horizontal, level "4"
Left and right side window, each 40 degrees vertical by 50 degrees horizontal, level "5"
Left and right side window, each 40 degrees vertical by 60 degrees horizontal, level "6"
Left and right side window, each 50 degrees vertical by 60 degrees horizontal, level "7".

Point Special Effects. This refers to those moving elements in the background scene content provided by the simulator's visual system. Point special effects are measured using examples which have been established by the model developer. The rule used in classifying the fidelity levels is as follows.

If the special effects in the background scene include:

No special effects, then the visual system's point type special effects are at level "1"
Cultural lights, level "2"
Cultural lights and weapons blast, level "3"

Cultural lights, weapons blast, and damaged vehicles,
level "4"
Cultural lights, weapons blast, damaged vehicles, and
airborne vehicles, level "5"
Cultural lights, weapons blast, damaged vehicles, airborne
vehicles, and moving ground vehicles, level "6".

Area Special Effects. This refers to the moving elements in the background scene content provided by the simulator's visual system. Area special effects are assigned using examples of special effects established by the model developers. The rule used in classifying the fidelity levels is in the following form.

If there are:

No special effects, then the visual system's area type
special effects are at level "1"
Smoke and dust, level "2"
Rotor wash effects, level "3".

Platform Motion. This refers to the number of degrees of movement made by the simulator platform about and along the horizontal, longitudinal and vertical axes of the simulated aircraft. Platform motion is measured using a 4-point scale that places that degrees of movement along a continuum. The rule used in classifying the fidelity levels is as follows.

If there is/are:

No platform movement, then platform motion is at level "1"
Three degrees of movement, level "2"
Five degrees of movement, level "3"
Six degrees of movement, level "4".

Seat Motion. This refers to simulator force-cuing devices that operate separately from the platform motion system, including seat shaker and g-seat. Seat motion is measured using examples of seat motion which have been established by the model developers. The rule used in classifying the fidelity levels has the following form.

If the seat motion include(s):

No motion, then seat motion is at level "1"
A seat shaker, level "2"
A seat shaker and a g-seat, level "3".

Sound Special Effects. This refers to those sound effects associated with aircraft operation. Sound special effects are measured using examples which have been established by the model developers. The rule used in classifying the fidelity levels looks like the following.

If the effects include:

No audio signals, then sound effects is at level "1"

Weapon firing, skid noise, and some failures, level "2"
Weapon firing, skid noise, some failures, and normal engine
operating noise, level "3"
Weapon firing, skid noise, some failures, normal engine
operating noise, and abnormal engine operating noise,
level "4"

Map Area. This refers to the size of the gaming area within which the simulator's visual system is capable of operating. Map area is measured using a 7-point scale that places the size of the area along a continuum. The rule used in classifying the fidelity levels is as follows.

If the size of the map area is:

5km x 5km, then the size of the map area is at level "1"
10km x 10km, level "2"
10km x 20km, level "3"
10km x 30km, level "4"
20km x 30km, level "5"
30km x 30km, level "6"
30km x 40km, level "7".

Instructional Features

Tutorial. A Tutorial provides instruction to students and/or instructors on the features, capabilities, and appropriate uses of the simulator and its instructional support features.

Scenario Control. Scenario control provides the instructor with capability to configure and to control the simulator so that simulated events occur according to a pre-planned specific training scenario.

Initial Conditions. Initial conditions provide the instructor the capability to preset initial environmental and vehicle dynamic parameters from a set of previously selected values with a minimum of effort.

Real-Time Simulation Variables Control. Real time variable control provides the instructor the capability to insert, remove, or otherwise alter simulator variables and parameters during training exercises.

Malfunction Control. Malfunction control provides the instructor the capability to insert simulated malfunctions manually or automatically into a training scenario.

Instructor Operating Station (IOS) Display/Annunciator and Repeater Instruments. This IOS display provides the instructor with a display of current student performance during the training exercise via student station instrument replication and/or CRT displays or exercise status and control data.

Procedures Monitoring. Procedures monitoring provides the instructor the capability to monitor and document performance of specific procedures from a display.

System Freeze. System freeze provides the instructor the capability to freeze the entire exercise for the purpose of training. It may be initiated manually by the instructor or automatically by exceeding pre-selected parameters.

Parameter Freeze. Parameter freeze provides the instructor the capability to freeze selected parameters of the training exercise for the purpose of training. It may be initiated manually by the instructor or automatically by exceeding pre-selected parameters.

Simulator Record/Replay. Record/replay is the simulator capability to record a student's actions and inputs during a training exercise. The simulator can dynamically replay the exercise or selected segments of the exercise for the student's review.

Automated Performance Measurement. Performance measurement is the simulator capability to calculate quantitative measures of student performance which will be used to assess student progress and to diagnose performance problems.

Hardcopy/printout. Hardcopy is the simulator capability to store/print data from any specified source connected with the simulation, including CRT display of graphic parameters and performance measurement for later debrief or record keeping.

Remote Graphics Display/Replay. Remote replay is the simulator capability to provide a graphic or symbolic display of student performance for instructor post scenario debrief at a remote computer graphics console.

Data Storage and Analysis. Data analysis is the capability of the simulator to store, analyze, and retrieve archival data pertaining to objectives attainment for individual students, groups, or the simulator.

Instructional Feature Benefit Weight. The instructional feature benefit weight reflects the frequency of need, instructor loading and feature usability of the instructional feature. In the original OSBATS data, these weights summarize research results (Pozella, 1983) in terms of probability that an instructional feature would be used if it were available on the simulator.

Cost Factors

Investment Cost. Investment cost for a training device represents the initial dollar amount spent for a simulator from conception through delivery, including initial training of instructors through facilities preparation. The investment cost for a training device is the sum of the nonrecurring cost components required to bring the device on-line, adjusted by the inflation factor for the year in which the training device investment occurred so that costs are expressed in a standard dollar. For long-range projects requiring investment over a period of years, a series of inflation factors are applied to the relevant year's costs. Estimates of the costs of the nonrecurring components include: front-end analysis, research and development, acquisition / contracting, device design, development, assembly, test evaluation, logistics support, contractor support, facilities / site preparation, initial training, and curriculum development.

Annual Fixed Operating Costs. The annual fixed operating costs include those costs which occur to maintain the device's availability for training even if no student training is conducted. The fixed cost is the sum of the individual components contributing to the maintenance cost of the training device. The support components for a specific trainer will depend on whether the device is maintained by contract personnel or by on-site employees who keep the device in working order as part of their regular duties. Estimates of the following components contribute to the fixed operating cost include: service contract costs, internal support costs, supplies and material for scheduled maintenance, and facilities costs.

Hourly Variable Operating Costs. The variable cost represents those expenses for maintaining a simulator that change as a function of student utilization. Variable cost is the sum of the individual components contributing to the hourly operating costs of the training device. Estimates of the costs per student-hour of the following components contribute to the operating costs: utilities, instructor salaries, instructional supplies, unscheduled maintenance, student salaries, extra hours of service added to basic fixed service contract, and building depreciation.

Life Cycle. Life cycle represents the projected useful life in years of the training device as estimated at the time of procurement.

Maximum Annual Utilization. This represents the maximum number of hours the training device can be utilized in one year. Training device utilization may be estimated through discussions with scheduling and utilization personnel or through quarterly summary utilization reports. Some of the factors considered in

the utilization figure are the number of hours the simulator is directed to be in use and the number of hours per year that the simulator is down for repair other than regular maintenance.

Minimum Cost. The minimum cost represents an estimate of the development cost for the lowest level of fidelity in that dimension of the training device. Development costs consist primarily of the initial software development, debugging, and special equipment needed to bring the dimension on-line.

Maximum Cost. The maximum cost of a fidelity dimension represents an estimate of the development costs for the highest possible level of fidelity in that dimension. Development cost consist primarily of software development, debugging, and special equipment needed to provide the state of the art for the dimension.

Instructional Feature Cost. Instructional feature cost is the acquisition cost of an instructional feature. Acquisition cost of instructional features consist primarily of the initial software development and debugging required to bring the feature on-line. These costs are reduced to a common base for comparative purposes.

Literature Review

The OSBATS model has been developed to aid the training system designer in making tradeoff decisions among various design features. These tradeoff decisions depend first upon linking task characteristics to specific simulator design features which can effectively teach the behaviors desired, and second to the costs for developing and implementing those design features in the simulators.

One of the challenges of the OSBATS model is to structure the relationship between tasks characteristics and fidelity information. The system uses task data and characteristics in terms of the required cue and response information to specify fidelity dimensions and levels for each task. These specifications are then used by OSBATS algorithms to generate overall benefit values for candidate fidelity dimension levels. These benefit values are evaluated against the cost of the features to generate a benefit-to-cost ratio for the fidelity dimension levels.

The prototype OSBATS models have been developed and implemented within the application area of training rotary-wing operations. The selection of rotary-wing operations training has imposed constraints on the tasks and design parameters considered by the models. At present the model is designed to make tradeoff decisions for a helicopter which operates at low altitudes, depends on use of visual and kinesthetic cues in guiding and

directing the flight path, and demands automatic emergency procedure behaviors of the pilot.

At the outset it was assumed that at least some of the resident data linking tasks to effective simulator design could be acquired from research literature, technical reports, and operator's manuals. A preliminary review of pertinent literature was begun with this goal. The remainder of this section identifies the literature reviewed and indicates the difficulties encountered in collecting resident data from the training research literature.

Defense Technical Information Center

The Defense Technical Information Center (DTIC) provides technical report summaries to Department of Defense personnel. Three technical report searches were initiated by the Government. The search strategy for the first report summary included the following first level search terms: adaptive training, air force training, apprenticeship, army training, computer aided instruction, flight simulators, flight training, gunnery trainers, individualized training, industrial training, job training, leadership training, management training, marine corps training, military training, naval training, programmed instruction, radar trainers, retraining, teaching machines, teaching methods, training, training devices, and training films. This search produced 280 technical report summaries, 19 of which appeared relevant to the collection effort. The technical reports deemed relevant through the DTIC searches are listed in The bibliography at the end of this report. The second search included the following search terms: simulation, simulator, training device, afterimages, color vision, flicker, illusions, night vision, peripheral vision, vision, visual acuity, visual perception. This search produced 121 technical report summaries, nine of which were related to helicopter simulation. The third DTIC search included the following search terms: simulation, simulator, training device, and fidelity. Twenty-three technical reports were identified, six of which were examined in more depth.

DTIC was expected to be the major source for training research information. Unfortunately this was not the case. The searches uncovered a limited number of technical reports specifically related to helicopter simulation. Of those technical reports related to helicopter simulation, there was not enough detail about the tasks or fidelity dimensions to satisfy the resident data collection effort. A bibliography of the reports reviewed follows the references. The reports are not reviewed individually here due to their lack of detailed information and the inability of basing general relationship rules on the documents.

Manpower and Training Research Information System

The Manpower and Training Research Information System (MATRIS) is a service provided through DTIC. This summary report selects active or planned research efforts from DTIC files based upon a key-phrase sort. The report lists the organization conducting the research, points of contact, a synopsis of the research, and progress to date, among other issues. The summaries reviewed had been selected in the areas of Training Devices/Simulation Data, Training Devices/Simulation Effectiveness, Training Devices/Simulation Database Management Systems, Training Devices/Simulation Fidelity, Instructional Design of Training Devices/Simulation, Training Technology, Training Cost, Training Instructional Approach, and Training Effectiveness Data. These key phrases produced 91 report summaries; however several of the reports were duplicated in other sections.

The MATRIS summary enables individuals conducting similar lines of research to contact each other. However the summaries suffer from a lack of detail and often outdated information which inhibit communication. None of the summaries selected by MATRIS addressed rotary-wing operation. For purposes of resident data collection for the OSBATS model, MATRIS is not a viable source of relational data.

Review Articles

Selected reviews are presented here to clarify some of the recognized problems of using the standard defense industry technical report as a sole source for OSBATS relational information. These reports encompass review articles (Semple, Hennessy, Sanders, Cross, Beith, & McCauley, 1981; Statler, 1981) a collection of annotated bibliographies (Ayres, Hays, Singer, & Heinicke, 1984) and a taxonomic approach that may aid data collection in the future (Kincaid, Andrews, & Gilson, 1987).

AirCrew Training. A report by Semple, Hennessy, Sanders, Cross, Beith, and McCauley (1981) reviews research describing aircrew training using simulation as one part of a total training system. The goal of the review was to locate documents for which performance of simulator trained subjects was evaluated during actual aircraft flight. Studies which only measured simulator performance were excluded. The review examined the relationship between aircrew training requirements and aircrew training device fidelity dimensions and levels for specific training tasks: individual and formation takeoff and landing; close formation flight and trial formation, both close and extended; aerobatics; spin, stall, and unusual attitude recognition, prevention and recovery; low level terrain following flight; air refueling; air to air combat (guns and missiles); and air to ground weapon delivery.

A total of 21 studies was found which satisfied the search requirements. These studies addressed transition and continuing training for routine flight tasks in fixed wing aircraft. However, Semple, et al. (1981) were unable to specify the necessary and sufficient conditions required for positive training transfer because there were not enough transfer studies available to draw conclusions about the effects of resolution, color, infinity versus real images, field of view, and their combinations. The inconsistencies in the published literature also made comparisons among the studies difficult because the studies address flying tasks with different subject populations, simulators used (which would have different fidelity dimensions and levels), aircraft involved, training methods used, and differing scoring techniques. These inconsistencies made it impossible to even isolate factors contributing to training effectiveness. Semple, et al. concluded that at present there is no systematic way of proceeding from task visual information requirements to the nature of the picture screen required because of a considerable gap in the knowledge of visual perception, human information processing and the characterization of the visual screens as means of providing information to pilots.

Individual chapters in the report (Semple, et. al., 1981) addressed different fidelity issues including cockpit visual system design and effectiveness, flight characteristics fidelity, platform motion systems, and force cuing devices. A conclusion drawn from the literature about visual system design and effectiveness is that experimental findings should not be generalized beyond the specific experimental circumstances to other aircraft types, simulators or training applications because so few visual topics important to visual simulation are addressed in more than one study.

The results of the review of platform motion found that although pilots say they prefer valid platform motion cues, they cannot tell when motion systems are on or off without out-of-cockpit visual cues. Semple, et. al. (1981) found little evidence in the nine training transfer studies to support the idea that platform motion cuing enhances training efficiency.

A second group of cuing devices referred to as "G-cuing" devices were assumed to enhance device efficiency or effectiveness by providing further realism in the training environment. It was suggested by Semple et al. that seat shakers and G-seats may be valid means of providing buffeting, yawing, and similar alerting cues which arise in normal and emergency flight training situations; however no research was found which examined the possible training value of these cuing devices.

The training tasks examined were primarily fixed wing training tasks. There is no line of research which compares the

training requirements of fixed wing and rotary wing aircraft, therefore generalizations should be limited. The Semple et al. study uncovered one transfer of training study for the UH-1H, however no training transfer was demonstrated (Bynum, 1978). Although this review was interesting, it demonstrated the research literature's inability to provide the detailed data required for the OSBATS resident database (rule systems).

Annotated Abstracts. The purpose of the annotated abstracts generated by Ayres, Hays, Singer, and Heinecke (1984) is to present detailed abstracts summarizing the research literature from 1957 until 1982 on simulation-based training devices. The literature studies were available from on-line data searches (e.g., NTIS, Psychological Abstracts) and include theoretical and review articles as well as empirical studies. The document contains abstracts of 149 articles organized into two main categories: empirical and theoretical. The 83 empirical articles were presented in one of five subcategories: experiments, surveys, case studies, analytical-systematic applications, and meta-analyses. The 66 theoretical abstracts were categorized into four groupings: theoretical, review, conceptual, and methodological.

Following their review of the literature, Ayres, et al. found that the simulator literature is characterized by extreme diversity in quality and validity. There were several shortcomings identified through this review which contribute to the inconsistency in the research findings. The simulator literature reviewed suffers from the following shortcomings:

1. No consistency in research objectives between experiments;
2. No consistency in experimental design and control between experiments;
3. Reliance on subjective judgments of flight instructors as a proficiency measure;
4. A trend toward smaller sample sizes;
5. No consistency in task selection between experiments;
6. Focusing on specific problems, thus restricting generalizability;
7. Lack of systematic investigation of fidelity effectiveness.

Although this report contains a very detailed account of the studies, it was not designed to provide the data required by the OSBATS model. Of the 83 empirical studies, six studies

investigated rotary wing devices. This bibliography also confirms that training effectiveness information is difficult to find on aircraft in general and rotary wing operations in particular.

NASA Working Group. The National Aeronautics and Space Administration (Statler, 1981) working group goal was to identify and define the physical parameters of the flight simulator visual system that characterize the system and determine its fidelity. The group attempted to establish the physical measures of image quality that are describable in objective terms, within the categories of spatial properties, energy properties, and temporal properties. Under the category of spatial properties, scene content was identified as an important measure of the quality of the visual simulation system; however, no standardized metric exists for scene content. For the concept of resolution, a transfer function was identified by the NASA group as a reliable measure for predicting performance of certain visual tasks. This metric included the effect of luminance, contrast, resolution, and noise, however there are no standardized techniques for measuring these factors and their relevance to visual simulator systems. With regard to color, a number of pilots expressed a desire for color, however the value of color has not been established empirically.

The problem as described by the NASA group is to identify visual cues for a particular task and then to translate functional definitions into visual simulation system characteristics. The only promising avenue identified by the group for collecting the information required was a series of transfer of training experiments and performance evaluation experiments in real aircraft. The group concluded that the more successful simulators have been based on requirements determined from thorough analyses of the tasks to be trained or researched in the simulator and the information necessary to perform the tasks.

There were several areas identified by the NASA group that need to be addressed in research and development programs. For example, research and development are required in the visual display and image-generation areas. Brightness and resolution approaching the capability of the human visual system appear to be required for use in fighter/attack aircraft simulators for displaying targets and threats at real detection and recognition ranges. Infinity optical mosaic and real-image dome display techniques need to be developed to provide the display resolution required. A second area for research includes the area-of-interest techniques, specifically to determine the peripheral resolution for depicting small dynamic imagery in area-of-interest displays. A related issue is the optimum way to blend the high detail and resolution into the lower detail and

resolution background so that the change is not distracting to the pilot.

This NASA working group (Statler, 1981) identified alternative measures of the visual factors included in the OSBATS model, yet could not provide standardized metrics for the visual factors. Again, this report was interesting, but it could not provide the information required by the current version of OSBATS.

Visual Display Taxonomy. A paper by Kincaid, Andrews, and Gilson (1987) describes an effort to define and categorize visual system variables which can be used to translate training requirements into visual system performance characteristics which can be communicated among various specialists, such as instructional technologists, visual engineers and human factors specialists. The physical characteristics of the visual display proposed in this taxonomy are similar to those identified by the NASA group. This type of taxonomy could be useful in classifying the type of visual display for research programs of training effectiveness. Table 4 presents the taxonomy developed by Kincaid, et al. (1987). This visual display taxonomy is divided into two characteristics - physical and functional. As a method for organizing this data collection effort however, this taxonomy was unable to provide any assistance for the current version of OSBATS.

Table 4. A Prototype Visual Display Taxonomy

Physical characteristics

- o Resolution - measured in lines per inch or pixels
- o Color capability - monochrome versus multiple hues
- o Brightness/contrast - level of ambient light under which display can be viewed comfortably
- o Update rate - rate at which information is brought to screen
- o Transport delay - lag delay
- o Display size - e.g., lines of resolution
- o Display type - e.g., CRT, vector-refresh CRT, plasma, CGI
- o Display for two- and three-dimensional trainers
- o Spatial features - e.g., field of view, range effects

Functional Characteristics

- o Data driving display (real-time as from camera-model board, photographic as from videodisc)
- o Scene management (e.g., focus attention, occulting)
- o Special features - texturing, moving models, reduced visibility effects, interactive networking

Conclusions. These reports, reviews, and bibliographies suggest that the data required to satisfy the OSBATS model are not readily available in print, from the government. This is discouraging since the simulator literature was anticipated to be the major source of training effectiveness information. There appears to be a great need for research aimed at specific relations between the tasks taught on the simulators and the specific fidelity dimensions required to train these tasks effectively.

Cross and Gainer (1987) have documented the types of research needed to determine the optimal design and use of Army flight simulators. In general these research topics include investigations of the relationship between fidelity in selected flight simulator design parameters and training transfer for selected flying tasks. The list includes investigations to define the relationship between flight simulator production costs and required fidelity in the selected flight simulator design parameters. Investigations are also needed to define the type, cost, and effectiveness of alternate training methods and media that could be used in lieu of extreme high fidelity flight simulators to train one or more of the selected flying tasks. Many of the lines of research are directly related to satisfying the OSBATS requirements.

There are other sources of literature that will be of considerable value in the generation of empirically based rules for OSBATS-like systems. The professional research literature contains some detailed information that can be used for generating relationship rules. For example, Kennedy, Berbaum, Collyer, May, and Dunlap (1988) have provided some fine-grained information about spatial and orientation requirements for detecting orientation of aircraft in simulations. The drawback is that the experimental conditions can be difficult to relate to military tasks, or require more fine-grained task analysis than usual.

Until these research studies have been conducted, other methods for data collection must be attempted. The program of data collection described in the next section, and used in this study, can provide an alternative method for collecting data until such time as the necessary research results become available.

Survey Methodology

The objective of this contract was to enrich the OSBATS database through the collection of required model data and to provide information for the construction of expert system rules for the Optimization models. In order to accomplish this the sources of data had to be identified; methods for collecting the data developed, tested, and implemented; and the information

correctly structured and entered into the database. The emphasis in the data collection effort was on the Army Aviation Operation course at Fort Rucker, Alabama, with a single visit to the basic armor maintenance course at Fort Knox, Kentucky.

Several of the data elements were expected to be available in simulator operator manuals (scene contents, motion, map area, etc.) and through the training research literature (training effectiveness) identified through DTIC. As the previous section indicated, the specific detail required by the OSBATS model for this domain was not available in these published sources. Therefore more extensive on-site examination of the simulators and discussions with training device operators and instructors were required to gather the necessary fidelity and instructional features data.

The objectives of this effort were accomplished in three stages. The first stage was a general survey of aviation training devices at Fort Rucker. The second stage was accomplished through a detailed survey of UH-1 CPT and AH-64 CWEPT simulator operators at Fort Rucker. The final stage was generation and evaluation of the device costs.

Training Device Capability Survey

The Government made the arrangements for the data collection effort through the Fort Rucker ARI office. A preliminary visit was made to Fort Rucker in June 1987 to examine the training devices first hand. Following this visit the Data Dictionary developed under the EER (1987) contract was expanded to include in-the-cockpit visual sensor information, functional/physical fidelity dimensions, and task information. A list of candidate devices was submitted to Fort Rucker officials and specific appointment times were arranged for collecting the device data. The expanded version of the Data Acquisition Form (Appendix A) and the Training Device Capability Survey (Appendix C), was completed on-site in October by contractor and Government personnel.

The data recorded using the Training Device Capability Survey were grouped into sets: fidelity dimensions required specifically by OSBATS, instructional support features available on the current trainers, visual fidelity dimensions of the in-the-cockpit sensor units, an evaluation of the physical and functional fidelity of the cockpit systems, and tasks taught on the trainers. The first three types of data were described in the previous section of the report. A description of the expanded dimensions follows.

The visual fidelity dimensions relevant to the cockpit sensor units include visual resolution, visual content, visual texture, field of view, and scene content (point and area special

effects). These dimensions were added to the survey in order to expand the information base for developing expert system rules. Expert system rules are used by the OSBATS model to assign fidelity dimensions and levels to tasks.

The physical/functional fidelity evaluation was limited to the equipment inside the cockpit. Physical fidelity refers to how similar the trainer is to the actual equipment. Functional fidelity refers to how well the actual equipment relationships are replicated between controls, displays and visual representations. As an example of functional fidelity, a pilot pushing forward on the cyclic would expect the attitude indicator to change. An attitude indicator that changes in a manner almost exactly like the actual equipment has high functional fidelity; an attitude indicator that does not move when the cyclic is changed has no functional fidelity for that flight display subsystem.

Space was available on the Training Device Capability Survey to describe the tasks trained on the simulators in order to establish a task-fidelity level link. The instructors assigned to the devices were asked to describe the tasks trained on the device. Unfortunately, the instructors were not able to provide task information at the level of detail required for modeling. In addition, the amount of instructor time required to describe the tasks was too extensive. Therefore task information on the surveys is limited.

Since recording instructor's descriptions of the training tasks taught in the simulator was unable to provide the level of detail required, student handouts containing a lists of the tasks to be taught in the trainers were collected from instructors. Surprisingly, task descriptions were not available for all the trainers. In addition, for some of the courses (e.g., the course utilizing the UH-1 CPT), the tasks list included the emergency procedure tasks, of which only half are taught routinely in the device. Requests for additional task lists were initiated through the Fort Rucker ARI Field Office. Copies of available materials were delivered, however those tasks lists were not device specific.

Training Device Capability Surveys were completed on selected trainers from four aircraft systems: AH-1S, AH-64A, UH-1H, and OH-58D. The specific AH-1 trainers included the Armaments Procedures Trainer (APT) and the Flight Weapons Simulator (FWS). The AH-64 trainers included the TADS Selected Task Trainer (TSTT), and the Cockpit Weapons and Emergency Procedures Trainer (CWEPT). The UH-1 trainers included the Cockpit Procedures Trainer (CPT) and the Instrument Flight Simulator (IFS). The OH-58D trainer was the Cockpit Procedures Trainer (CPT) under acceptance testing by the Army.

AH-1S Cobra Flight Weapons Simulator. The AH-1S Cobra is a combat helicopter for anti-armor ground attack. The AH-1 FWS is designed to provide transition training, proficiency flying, and weapons delivery practice on a 20mm cannon, 2.75-inch Folding Fin Aerial Rockets, and a tube-launched, optically tracked, wire-guided (TOW) missile. The simulator can be used to train aviators to perform all normal and emergency flight maneuvers, weapons delivery operations, nap-of-the-earth flight and navigation, as well as starting, runup, and shutdown procedures. It is capable of training both the pilot and gunner simultaneously on the same mission or independently on different missions.

The AH-1 FWS consists of two instructor/student stations equipped with visual display systems. The student pilot station is a replica of the aircraft pilot position and includes facsimiles of the cockpit window arrangements. The pilot seat, instrument panel, flight controls, helmet sight subsystem, head up display, and left and right equipment consoles, are actual aircraft parts. The student gunner station is a replica of the aircraft gunner position. Actual aircraft cockpit equipment includes the main instrument and control panel, left and right equipment consoles, flight controls, helmet sight subsystem and telescopic sight unit.

AH-1 Armaments Procedures Trainer. The AH-1 APT is designed to train pilots and gunners to perform arming tasks and to provide weapons delivery practice. The device is capable of training the pilot and gunner simultaneously or independently. The device consists of an instructor and a student station. The student pilot station is a replica of the aircraft pilot position and includes facsimiles of the cockpit window arrangements. The pilot seat, flight controls, heads up-display, and left equipment console are actual aircraft parts. The right equipment console and the instrument panel are presented as nonfunctional line drawings. The student gunner station is a replica of the aircraft gunner position. Actual aircraft cockpit equipment includes the left and right equipment consoles, flight controls, and telescopic sight unit. The instrument panel is presented as nonfunctional line drawings.

AH-64 Cockpit, Weapons, and Emergency Procedures Trainer. The AH-64A Apache is a combat helicopter for anti-armor ground attack whose missions are flown at night or during adverse weather in low-visibility environments, aided by highly sophisticated sensors. The AH-64 CWEPT is designed to train pilots and gunners to perform normal and emergency procedures, weapons delivery operations for a 30mm cannon, 2.75-inch Folding Fin aerial rockets, and Hellfire missiles, as well as starting, runup, and shutdown procedures. It can be used to train both the pilot and gunner simultaneously or individually.

The AH-64 CWEPT features an independent student cockpit with an off-board instructor/operator station. The student pilot station is a replica of the aircraft pilot position and includes facsimiles of the cockpit window arrangement. The pilot seat, instrument panel, flight controls, helmet sight subsystem, visual display unit, and left and right equipment consoles, are actual aircraft parts. The student gunner station is a replica of the aircraft gunner position. Actual aircraft equipment includes the instrument panel, left and right equipment consoles, flight controls, and optical relay tube controls and displays.

AH-64 TADS Selected Tasks Trainer. The AH-64 TSTT is designed to train pilots to operate the Target Acquisition and Designation system. The TADS system includes a day television with magnification, forward-looking infrared sensor, laser rangefinder, laser tracker, direct view optics and image auto tracker. The device itself consists of a computer terminal, fire control panels, and an optical relay tube with controls and displays. The trainer is designed to familiarize students with the use of the TADS without an instructor. Instructions for the student operating the trainer are provided through an on-line delivery system. The student interacts with the trainer through a keypad.

UH-1H Instrument Flight Simulator. The UH-1H is a utility helicopter for troop transport, cargo transport and medical evacuation. The UH-1 IFS is designed to train aircraft instrument flight maneuvers such as ground control approach, nondirectional beacon approach and instrument landing system approach for initial, refresher and instrument training. The simulator itself features four independent cockpits that interface with the main computer system and an off-board central operator station. Each of the cockpits has pilot, co-pilot and instructor pilot positions.

UH-1 Cockpit Procedures Trainer. The UH-1 CPT includes an instructor and a student position. The student position is a replica of the aircraft. Actual aircraft cockpit equipment includes the instrument panel, center equipment consoles, and flight controls. The device is designed to provide initial training for normal and emergency operating procedures.

OH-58D Cockpit Procedures Trainer. The OH-58D helicopter is designed for close combat aerial reconnaissance, intelligence gathering, surveillance and target acquisition. It incorporates a mast mounted sight that enables the crew to perform aeroscout missions while remaining partially masked. The helicopter's laser range finder/designator is used for weapons guidance and target handover to an attack helicopter. The helicopter is capable of performing these missions day or night, in limited adverse weather and obscured battlefield conditions, and at nap-of-the-earth flight altitude. The OH-58D trainer is designed

to provide initial, refresher, and transition training to pilots and observers. The basic training tasks supported include aircraft normal and emergency procedures, instrument flight maneuvers, target identification, and target handover. The trainer includes an instructor and a student station. The student position is a replica of the aircraft and includes the instrument panel, center equipment console, and flight controls.

Training Device Task Survey

The central concern of training device designers is the selection of the most effective areas in which to provide design sophistication and/or instructional support. There are a number of areas which can be developed to either a greater or lesser extent. The investment of resources in these areas, such as the device's visual system or the inclusion of a specific instructional feature, depends on the requirements of the tasks to be trained on that device. An effectively designed training device depends upon information relating tasks to design sophistication and instructional features.

The second segment of this data collection effort was aimed at gathering some of the task/fidelity and task/instructional feature data needed to design effective training devices. Two Training Device-Task Survey forms were developed, one for the UH-1 CPT (Appendix D) and one for the AH-64 CWEPT (Appendix E). These surveys were based on the training-device data collected at Fort Rucker and the available task materials, which included instructor guides and student handouts.

These two training devices were selected to generate information for expert system rules for two reasons. First, these two trainers are procedures trainers and therefore possess different fidelity dimensions and levels, as well as different types of instructional features, than the features currently in the Database (i.e., drawn from the AH-1). Second, task lists were available which clearly indicate which tasks were intended to be taught using the training device. For the UH-1 CPT the task list included 25 emergency procedure tasks. The tasks for the AH-64 CWEPT were divided into Front Seat (i.e., gunner) and Back Seat (i.e., pilot) tasks. There were 41 tasks taught in the front seat position and 48 taught in the back seat.

The survey of the UH-1 CPT using the Training Device Capability Survey identified three instructional features, two sound effects, and four types of cockpit displays on the device. These features were crossed with the 25 emergency procedures tasks to form the UH-1 CPT questionnaire. For the AH-64 CWEPT at the gunner's position, the device capability survey identified ten instructional features, three visual design features, seven scene content images, three special effects, and six types of cockpit displays. These features were crossed with the 41 gunner

tasks to form the basis of the AH-64 CWEPT gunner questionnaire. For the AH-64 CWEPT at the pilot's position, the capability survey identified ten instructional features, eight visual design features, seven scene content images, three special effects, and six types of cockpit displays. These were crossed with pilot's tasks to form the matrix for the AH-64 CWEPT pilot questionnaire.

Each section of the questionnaires contains instructions explaining how to complete that section of the survey. The first section of the questionnaire requested demographic information. The second section required evaluations of the overall effectiveness of the instructional features for providing training on the simulator. A five-point scale ranging from "very ineffective" to "very effective" was used (based on Pozella, 1983). The third section required an assessment of the effectiveness of the instructional features for training specific tasks, using a seven-point scale ranging from "unacceptable" to "superior." The fourth section of the survey requested an assessment of the fidelity adequacy of specific design features for task training. The respondents rated each feature as "adequate," "less fidelity could be used," "more fidelity could be used," or "not appropriate for this task." The fifth section required the instructor to evaluate the utility of the visual scene content and the special effects for task training. The respondents entered a Y or N to indicate whether they used an image. The last section asked the respondents to rate the fidelity adequacy of the displays and controls for the tasks trained in the simulator using the "adequate" to "not appropriate" scale previously used in section four. Additional space was available at the end of the sections for the respondents to amplify their responses.

The questionnaire was administered at Fort Rucker to small groups of instructors during a break in the training cycle. The instructors were briefed on the purpose of the questionnaire and copies were distributed to them. The monitor reviewed the instructions for completing the questionnaire and reminded the instructors that the scale changed when they reached the different sections. As part of the general orientation to the task, the instructors' contribution to the effort was stressed, especially their unique knowledge about how training is actually conducted on the simulator. The UH-1 CPT instructors completed the survey in 4 hours. The AH-64 CWEPT instructors completed the surveys for the Gunner and Pilot positions over a three-day period.

Survey Results

Eight simulator instructors familiar with the UH-1 completed the task survey for the UH-1 CPT, and nine AH-64 instructors were given the survey for the AH-64 CWEPT. All the UH-1 CPT instructors were mid-level (E 5-7) enlisted personnel. The CWEPT

instructors were all civilians (GS-9's) with the exception of one enlisted instructor (an E-7). One of the CPT instructor's data was dropped from the task evaluation because of inexperience with the training device (he had taught using the device for less than one month).

Based upon their responses to the demographic information, there were considerable differences in the experience of the instructors assigned to the AH-64 CWEPT and the UH-1 CPT. None of the CPT instructors have any helicopter experience, while the CWEPT instructors have flight experience. Table 5 shows the range of helicopter experience for the CWEPT instructors. There are also differences in the amount of experience the instructors have in using the devices to training. The CPT instructors experience has been limited to the CPT; the CWEPT instructors have experience with a range of devices. Table 6 shows the range of devices and the number of months of experience for the CWEPT instructors. Since the CPT instructors' experience is limited to the CPT, the amount of training they have received on using instructional features would also be limited. Table 7 shows the average number of hours of training the CPT and the CWEPT instructors reported receiving on specific devices.

Table 5. Average Hours of Helicopter Experience

<u>Aircraft</u>	<u>Instructor</u>			
	CWEPT	(n)	CPT	(n)
UH-1	2680	(5)	-	(8)
UH-60	75	(1)	-	(8)
OH-58	564	(5)	-	(8)
OH-23	137.5	(4)	-	(8)
OH-13	762.5	(4)	-	(8)
OH-6	446.67	(3)	-	(8)
CH-54	2000	(1)	-	(8)
CH-47	3400	(1)	-	(8)
AH-64	-	(9)	-	(8)
AH-1	475	(2)	-	(8)
TH-55	343.33	(3)	-	(8)

Table 6. Average Months of Training Device Experience

<u>Device</u>	<u>Instructor</u>			
	CWEPT	(n)	CPT	(n)
UH-1 FS	76	(6)	-	(8)
CH47 FS	36	(3)	-	(8)
UH60 FS	22.5	(4)	-	(8)
AH1 FWS	28	(3)	-	(8)
UH-1 CPT	23	(4)	20.25	(8)
AH-1 APT	4.5	(8)	-	(8)
AH-64 TSTT	15.43	(7)	-	(8)
AH-64 CWEPT	26.44	(9)	-	(8)
OH-58 CST	2	(1)	-	(8)

Table 7. Average Hours of Training Received on Instructional Features

Device	CWEPT		Instructor		CPT			
	Class	(n)	Hands-on	(n)	Class	(n)	Hands-on	(n)
UH1 FS	68.33	(6)	396.67	(6)	-	(8)	-	(8)
CH47 FS	110	(1)	66.67	(3)	-	(8)	-	(8)
UH60 FS	30	(1)	20	(4)	-	(8)	-	(8)
AH1 FWS	30	(1)	43.33	(3)	-	(8)	-	(8)
AH-64 CMS	5	(1)	17	(2)	-	(8)	-	(8)
UH-1 CPT	39	(5)	54	(5)	4.5	(4)	21	(7)
AH-1 APT	36.83	(6)	35.14	(7)	-	(8)	-	(8)
AH-64 TSTT	23.33	(3)	36.5	(8)	-	(8)	-	(8)
AH-64 TSTT	150	(7)	183.75	(8)	-	(8)	-	(8)
OH-58 CST	250	(1)	60	(1)	-	(8)	-	(8)

Overall Effectiveness of Instructional Features. The instructors were required to rate the overall effectiveness of the instructional features for training. This question was based on Pozella's research (1983) and was included in order to establish a baseline for comparing the instructors' responses. The Pozella (1983) technique used an eight-point successive category scale. The eight dimensions required greater distinctions among the instructional features than was warranted, therefore a five-point successive category scale was substituted. The instructional feature research conducted by Pozella (1983) for Air Force Systems Command was intended to document and compare the utilization of instructional features, to document and compare the training value of instructional features, and to compare the training value and utilization patterns in continuation and replacement units. The Pozella objectives were accomplished through surveys of flight instructors from Tactical Air Command (F-4, F-15, A-10, E-3A). The results of this survey seem to indicate that utilization of the instructional features can be increased with instructor training. That is, as training increases the training value of the feature became more apparent to the instructors and subsequently the features were used more often.

The OSBATS model developers included an assessment of the usability of the different instructional features as a weighting function in the instructional feature benefit algorithm. Table 8 summarizes the instructors' ratings on the two simulators. In addition to the average ratings, the table shows the number of instructors responding to the item, and the range of rating points assigned to the instructional feature. As can be seen from the table, instructional feature effectiveness scores ranged the full scale on almost every feature. In addition, some instructors were unaware that a particular feature was available on their simulator. Since instructors evaluated the

Table 8. Instructional Feature Overall Effectiveness Rating

Training Device Feature	CWEPT			Pilot			CPT		
	Avg	(n)	Rng	Avg	(n)	Rng	Avg	(n)	Rng
Data Analysis	n/a			n/a			1.57	(7)	1-5
Hard Copy	1.29	(7)	1-2	1.57	(7)	1-4	n/a		
Initial Conditions	3.22	(9)	1-5	3.22	(9)	1-5	n/a		
IOS Display	3.11	(9)	1-5	3.00	(9)	1-5	n/a		
Malf. Insertion	4.22	(9)	3-5	4.12	(8)	3-5	4.43	(7)	4-5
Parameter Freeze	2.56	(9)	1-5	2.89	(9)	1-5	n/a		
Perf. Measurement	2.89	(9)	1-5	2.78	(9)	1-5	1.67	(6)	1-3
Procedures Monitor	2.78	(9)	1-4	2.78	(9)	1-4	n/a		
Scenario Control	3.00	(7)	1-5	2.68	(8)	1-5	n/a		
System Freeze	3.33	(9)	1-5	3.44	(9)	1-5	n/a		
Variable Control	2.56	(9)	1-5	2.67	(9)	1-4	n/a		

Note: n/a = The feature is not on the training device.

instructional features on the CWEPT twice (once for the gunner position and once for the pilot position), an inter-rater reliability was calculated. The reliability found, $r=.94$, indicates a high degree of consistency in the CWEPT ratings for the two positions.

Overall Usage of Instructional Features. Instructors also rated the frequency with which they used an instructional feature. This question was also based on Pozella's research for the Air Force Systems Command. These instructor ratings are used by OSBATS to prioritize instructional features on the basis of the potential training benefits that may accrue. Features which the instructors indicated they used more often receive higher priority. Table 9 summarizes the instructors' ratings on the two training devices. In addition to the average ratings, the table shows the number of instructors responding to the item, and the range of rating points assigned to the instructional feature. As the ratings indicate, instructional feature usage varies across the different instructional features. From these ratings, the instructional feature which will most likely receive the highest priority in selecting instructional features for procedures trainers is Malfunction Insertion.

Table 9. Instructional Feature Overall Usage Rating

<u>Training Device</u> <u>Feature</u>	<u>CWEPT</u>			<u>CPT</u>		
	<u>Avg</u>	<u>(n)</u>	<u>Rng</u>	<u>Avg</u>	<u>(n)</u>	<u>Rng</u>
Data Analysis	n/a	-	-	4.60	(7)	4-5
Hardcopy	1.30	(7)	1-5	n/a	-	-
Initial Conditions	4.50	(9)	1-5	n/a	-	-
IOS Display	3.20	(9)	1-5	n/a	-	-
Malf. Insertion	5.00	(9)	5	4.70	(7)	4-5
Parameter Freeze	3.10	(9)	1-5	n/a	-	-
Perf. Measurement	1.60	(9)	1-5	4.10	(6)	2-5
Procedures Monitoring	2.40	(9)	1-5	n/a	-	-
Scenario Control	3.60	(7)	1-5	n/a	-	-
System Freeze	3.10	(9)	1-5	n/a	-	-
Variable Control	3.50	(9)	2-5	n/a	-	-

NOTE: n/a = The feature is not on the training device.

Overall Review of Task Survey

The goal of the task by instructional feature/fidelity dimension questionnaire was to provide data from which expert system rules could be developed. These rules will be used by a future version of the OSBATS model to assign instructional features and fidelity dimension levels to tasks similar to the ones used in this survey.

UH-1 Cockpit Procedures Trainer. The UH-1 CPT design incorporated three instructional features. These features were: data analysis, malfunction insertion, and performance measurement. As configured on the trainer, data analysis was a primitive counting feature which summed the results of the performance measurement. Performance measurement tallied the number of errors committed by the students. Malfunction insertion enabled the instructor to insert malfunctions prior to or during the exercise.

The task by instructional feature data can be used to guide the development of expert system rules for assigning instructional features to tasks. The rules identify task types which can benefit from the use of instructional features during training. Since the rules developed can only be as good as the material on which they are based, the tasks must be analyzed for detailed characteristics. However, until further task analyses can be performed, certain preliminary conclusions can be drawn from general knowledge of the tasks.

The general rule development guide that was adopted is that rules should be developed for those instructional features which have a median task rating of 4 (i.e., "average") or greater, and for which the range of task ratings is 4 to 7 or narrower. In

other words, if even one instructor rated the instructional feature as "unacceptable," "poor," or "fair," for the task, then no selection rule was developed.

Using this selection criteria, there are no rules which should be written for the "data analysis" instructional feature. All task medians indicated that data analysis was less than "average" in its task training value. Ten tasks had medians of 4 or greater for malfunction insertion, with a sufficiently narrow range. However, none of the ratings for performance measurement had sufficiently narrow range, although nineteen of the tasks received a median ranking of 4 or better.

As an example, the instructors' ratings indicate high agreement on the effectiveness of malfunction insertion for training "emergency procedures for engine overspeed." The median rating was "good (5)" with a range from "average" to "superior." This would be an appropriate task by instructional feature combination on which to base an expert system rule. A rule for malfunction insertion based on this task should be:

IF the task involves learning emergency procedures,
and the emergency can occur at any time during operations,
THEN the Instructional Features list should include Malfunction
Insertion.

The rule written in this way will overgeneralize to many emergency procedure type tasks. This tendency to overgeneralize can be tightened up somewhat through a detailed task analysis of the tasks.

The UH-1 CPT design incorporated two levels of the fidelity dimensions used by the OSBATS model - normal and abnormal audio effects. However, the range of these audio effect sounds was limited to three distinct sounds.

Using the same general argument as before, the data provide a basis for developing preliminary rules for those fidelity dimensions in which there is high rating agreement on the adequacy of the features. It is reasonable to say that no rule should be developed if two or more instructors rated the fidelity dimension as "less than adequate" or "not appropriate," so that criteria was used to restrict the range (or indicate agreement). As an example, the instructor's ratings indicate agreement on the effectiveness of normal sound effects for training "emergency procedures for compressor stall." A rule for sound effects based on this task could be:

IF the task involves learning emergency procedures,
and the cue for initiation is auditory,
THEN the Fidelity Dimensions list should include sound effects.

UH-1 CPT instructors also responded to the appropriateness and physical fidelity adequacy of four systems - electrical, fuel, engine, and flight. As was the case above, rule development should be limited to those systems for which there is high instructor agreement on the adequacy of the system. There is high agreement on the adequacy of the electrical displays for training a number of CPT tasks. As an example, the instructors' ratings indicated high agreement on the adequacy of the electrical display for training "emergency procedures for transmission oil pressure low." A rule for display adequacy based on this task could be :

IF the task involves learning emergency procedures
and psychomotor complexity is moderate,
THEN the displays should replicate actual equipment.

AH-64 Cockpit, Weapons, and Emergency Procedures Trainer.
The AH-64 CWEPT design incorporated ten instructional features. These features were: hardcopy, initial conditions, IOS display, malfunction insertion, parameter freeze, performance measurement, procedures monitoring, scenario control, system freeze, and variable control. As configured on the trainer, a hardcopy printout was available from a remote terminal, not conveniently accessible to the instructors. The initial conditions feature allowed the initiation of conditions through a hand held keypad or an instructor's console. The IOS display enabled the instructor to view what the pilot or gunner viewed, as well as additional flight control information on a computer terminal. Malfunction insertion enabled the instructor to insert malfunctions prior to or during the exercise through the hand held keypad or instructor's console. Parameter freeze was capable of freezing the ground position only. According to the instructor interviewed about these features, the performance measurement feature had a limited data bank on the CWEPT. Procedures monitoring information was displayed on the IOS console. Scenario control was effected through the hand held keypad or the instructors console. Variables control was also effected through the hand held keypad or the instructors console.

Based on the rule development criterion (i.e. median rating of "4" with a narrow range of ratings), no rules should be developed for hardcopy, initial conditions, IOS display, parameter freeze, procedures monitoring, scenario control, system freeze, or variable control because the median ratings for all task were less than "average (4)." However the instructors' ratings indicate that malfunction insertion is effective for training emergency procedures to pilots and performance measurement is effective for training weapons procedures to

gunners. An example rule based on this training effectiveness data could be:

IF the task is procedural
and task performance involves discrete steps,
THEN the Instructional Features list should include
performance measurement.

The AH-64 CWEPT design incorporated two fidelity dimensions used by the OSBATS model - sound effects and size of gaming area. Although not currently addressed by the OSBATS rules, information addressing the in-the-cockpit visual display units available on the CWEPT was also collected for use in generating expert system rules.

It seems reasonable to develop rules from the task by fidelity dimension tables for those fidelity dimensions in which there was high rating agreement on the adequacy of the features. In other words, if no more than 1 instructor rated the fidelity dimension as "less than adequate" or "not appropriate" a rule could be proposed. The rationale used to make recommendations about rules based on this data is, of course, strictly a judgment. As an example, the instructors' ratings indicate high agreement on the adequacy of the sound effects dimension. These ratings add support to the UH-1's Task Survey findings on sound effects. The rule of thumb seems to be that cues which initiate emergency procedures should be incorporated in the training device.

The AH-64 CWEPT responses to the questionnaire provided information on the appropriateness and physical fidelity adequacy ratings of six systems - fuel, engine, flight, navigation, weapons, and communication - for both the gunner and pilot position. Again, rule development should be limited to those systems for which there is high instructor agreement on the adequacy of the system. As an example, for the task engine run-up procedures the instructors' ratings indicate high agreement on the adequacy of the fuel, engine, and flight controls for training this task. An expert system rule based on this data could be:

IF the task involves learning emergency procedures
and the task involves integrated steps,
THEN the cockpit controls should have high functional fidelity.

Expert system rules should not be written in a vacuum. The results of the task by feature survey can serve as an excellent source of information for writing preliminary rules specifying fidelity dimensions or instructional features for general task characteristics. Due to the low number of instructors completing the survey and the kinds of disagreements indicated in the ratings, the results should also provide the basis for designing

a structured interview that would clarify some of the task data. The task information could guide the discussion and could be altered as a result of the analyst's interaction with the training system expert. These kinds of interviews are common in the knowledge engineering process.

Cost Collection Methodology

The factors required by the OSBATS model to perform cost analyses include the device investment cost; the fixed cost per year for operating the device; variable cost per hour; anticipated life-cycle for the training device; and projected device utilization, in terms of hours per year. Additional factors are the instructional features acquisition cost, and the cost of minimum and maximum levels in the fidelity dimensions. The Data Acquisition Guide developed by EER (1987) was used to guide the development of the data collection forms for this effort. The data collection form used is provided in appendix C.

At the outset it was assumed that at least some of the cost data required by the OSBATS model had been systematically collected by agencies within the Federal Government such as the Training and Performance Data Center (TPDC) and that these data could be reformatted for use within OSBATS. Contact with TPDC personnel was made to investigate the available training device cost data. Some partial cost data were provided by TPDC, however not enough to make the estimates needed. Next, subject matter experts in the procurement of simulators from the Naval Training Systems Center were interviewed about the sources of cost data they used.

Because organized cost databases do not exist, most of the Navy SMEs used cost estimating relationships to predict the cost of various types of simulator features or historical contract files. Two cost models were recommended by the SMEs and investigated for applicability: Parametric Cost Models by RCA Price Systems and Constructive Cost Model by Barry Boehm (1981).

The Parametric Cost Model (PRICE) is a series of decision support systems which emphasize the areas of cost and scheduling. PRICE uses a parametric approach to estimating which accounts for variations in observations (i.e., costs) on the basis of variations of the factors on which these costs depend. The effective use of the PRICE system depends on tuning or calibrating the model using exact values from the organization's past experience. Since one of the difficulties has been the lack of exact values, the PRICE system was rejected.

The second cost estimating model, the Constructive Cost Model (COCOMO), estimates software development costs based on the size of the software product in terms of instructions, i.e., a line of code. Since a large percentage of the costs in fidelity

and instructional features are software costs, this model was selected to provide costs for these two clusters of data elements for the OSBATS model.

The cost related data required by the OSBATS model and generated using the COCOMO process is presented in Table 10. These cost values are based on three types of trainers: a Cockpit Procedures Trainer (CPT) for the UH-1, a Cockpit, Weapons, and Emergency Procedures Trainer (CWEPT) for the AH-64, and an Operational Flight Trainer (OFT) for the UH-60. The UH-1 and AH-64 trainers were used in generating data for investment costs, fixed cost per year, variable cost per hour, life-cycle, and utilization hours per year. The instructional features and the fidelity dimensions currently implemented in the OSBATS model were not present on these trainers, therefore the Navy's UH-60 OFT was used to generate the costs for those features.

Table 10. Cost Data for OSBATS - Generated by COCOMO Method

COST FACTOR	UH-1 CPT	AH-64 CWEPT	UH-60 OFT
Invest Cost	497000	2749000	6128000
Fixed Cost	76000	143000	449000
Variable Hr. Cost	37	53.5	83
Life-Cycle	20 Yrs.	20 Yrs.	20 Yrs.
Utilization Per Year	3880 Hrs.	3880 Hrs.	3960 Hrs.

Investment Costs. Investment costs are nonrecurring costs required to design, develop, produce, test, and install a training device. Investment costs occur during those periods in the development of a device from initial conception through device delivery. Part of these costs cover government personnel contracting and managing expenses. Other costs are those of the vendor in carrying out the contract. These costs and the methods used in arriving at them are outlined below.

Costs incurred by government personnel in preparing and administering a device development contract include the following elements. Front-end analysis costs are costs incurred by the government in performing task analysis and related functions. Based on a SME analysis of a sample of contracts, front-end analysis costs are assumed to be equal to 5 per cent of the contractor systems engineering effort (these systems engineer costs can be obtained from awarded contract proposals). Research and development costs are those costs incurred by the government which concern the application of innovative technology to be included in the engineering specification. It is assumed to be equal to 20 per cent of the contractor systems engineering effort. Acquisition/contracting costs must be estimated by a SME and cover the labor of the contracting department and related

support by the government project team during the development of the acquisition package and in managing the contract.

There are seven contractor type investment cost factors in device development contracts. In many contracts these factors make up the entire cost of the contract. These individual cost elements are described here to achieve standardization of OSBATS data across contracts and to make clear the types of contractor effort included in each category.

The cost for device design, development, assembly, test, and evaluation is a contractor cost that is estimated by the SME after analyzing a series of contracts for similar devices. Supporting items in the contract include integrated logistic support (ILS), and contractor support in the form of field service technicians to assist in the operation and maintenance of the device until fully accepted by the government. Also included is initial training which includes the development of training programs for technicians that will operate and maintain the device, and the training of the initial team of support personnel. In some instances acquisition cost includes curriculum development, which is the preparation of detailed exercise plans for use in the device. A category of "Other" is used to capture various other costs and is generally estimated to be 10 per cent of the overall effort. Another name for this category could be "program management". All of these contract costs are estimated for a specific class of trainers by SMEs after careful review of existing contracts.

Fixed Costs Per Year. Fixed cost per year is the annual cost for making a trainer available for training irrespective of how much student training takes place. This factor is made up of the costs for the maintenance service contract, internal support, supplies, materials, and facilities. These costs are described below, and in each instance are determined by an SME after inspecting historical documents.

Devices are typically maintained by a vendor under contract to the government. Service contracts provide for this service. The cost of this service is approximately \$20,000 a year for each assigned technician. Typical manning for a device such as a position trainer is 8 service technicians. This provides for two 8-hour shifts of utilization a day. Two technicians would be available each training shift and four for a maintenance shift. Once a service contract is signed, these costs are relatively independent of actual utilization.

Internal support costs include such annual expenses as publication updates and corrections, special tools and test equipment. In addition certain supplies and materials are consumed at the trainer site. Included are spare parts which

will average \$4500 a month for a device of operational flight trainer complexity.

Facility cost for the purpose of the OSBATS model includes only the cost of electricity. This cost varies by the power demand of the device and the local cost of electricity. Because the trainer and air conditioning systems have power on when idle, the cost of electricity is considered a fixed annual cost. As an example the 2F132, an OFT, at one location uses approximately \$2000 a month for electricity.

Variable Cost Per Hour. Variable costs represent the expenses that increase as the device is used. When the trainer is used for training there are costs in addition to the fixed annual costs. These additional costs are expressed as variable costs per hour of student use of the trainer. Included are instructor and student salaries, supplies, unscheduled maintenance due to system failure during use, and a prorated share of additional contract service charges resulting from using the trainer more than provided for in the service contract. Each factor will be separately considered.

Instructor salaries, as used in the OSBATS model, are simply the salaries received by the instructors. If the instructors are members of the armed forces, salaries are the pay and allowances based on the average pay grade of the instructors. If instructors are pilots then flight pay is included in the average hourly rate. For civilian government and contractor instructors this figure is based on their annual salaries. No indirect costs are included in this cost factor.

Instructional supplies refers to materials consumed during the teaching process. This includes a prorated share of the reproduction cost of audio-visual materials.

Unscheduled maintenance concerns system failures and the fault isolation and repair of these failures. In this model the repair of these system failures is charged to student use of the training. However, it should be noted that scheduled maintenance is charged to fixed cost per year, not variable cost per hour.

Student salaries refers to the direct hourly pay received by the student using the trainers. This includes pay and allowances calculated for the typical military student. Also included is a prorated share of flight pay if students are in flight status. It does not include indirect costs.

A cost factor for extra hours of service added to a basic fixed service contract refers to a charge to the government when the trainer is scheduled and used more than contracted for in the contractor supporting services contract. The rate charged by the vendor for additional hours is usually in the basic contract.

This cost factor is estimated based on the history of this type of contract in the command being supported.

Building depreciation is charged under the heading "other" on the data collection form. This charge is estimated by determining the local lease rate for equivalent space. While the government generally does not lease buildings for simulators, the actual government cost of owning a building has been determined to be similar to commercial cost, and lease rates are a convenient expression of that cost.

Life-cycle. Life-cycle refers to the number of years the government expects to use a simulator. The value is typically included in the simulator specifications. In actual practice, the useful life of a simulator is effected by the life cycle of the operational system being supported. Both factors are considered in the OSBATS life-cycle factor. In general the industry standard life-cycle varies from 15 to 20 years. In addition the estimated life-cycle of the actual equipment supported by the training device influences the life-cycle of the training device. A subject matter expert estimates the life-cycle anticipated for the actual equipment. Industry standards and estimated life-cycle are averaged to generate an OSBATS value for life-cycle.

Utilization Hours Per Year. Utilization is a measure of the rate a trainer is used for training. It is expressed in hours of use per year. This figure can be estimated by subtracting the projected annual hours lost to training due to system failure from the annual number of hours the trainer is scheduled for training. A subject matter expert makes these estimates.

In making this assessment, the "hours per year the simulator is used" factor refers to planned use. The school projects the number of students using the trainer, the number of hours of trainer time required in the curriculum, time required by new instructors to become familiar with the trainer, and other training demands. The manning and maintenance support of the trainer is based on this plan.

The factor "hours per year the simulator is down for repair other than maintenance" refers to time lost to the training schedule due to equipment failure. In a trainer under development this estimate is based on the engineering goals for mean time between failure and mean time to repair. Once the trainer is in use, this factor is based on the historical record.

Instructional Features. The OSBATS model requires cost values for individual instructional features. The approach selected to generate cost values for these features required a special application of the COCOMO model. The methodology employed by COCOMO estimates man-months required to develop

software. Man-months can be readily converted to dollars. Since the major component of instructional features is software, a methodology for projecting software costs is an appropriate approach. However if the number of source lines of code (SLOC) for the typical implementation of each type of instructional feature is available, then the direct conversion of SLOC to labor hours and therefore dollars would be a straightforward process. However, SLOC data are available for only a few types of instructional features. It is useful only to spot check the accuracy of COCOMO predictions.

The specific feature of COCOMO used in this application is the method for estimating effort in man months (MM) for standard sized products. Table 11 in this report is a part of a larger table used in the COCOMO handbook. The first step in applying COCOMO is to identify the types of training devices that correspond to the standard sized products listed in Table 11. In this instance "small" is equated to familiarization trainers, "intermediate" to part task trainers, "medium" to position trainers, "large" to crew trainers and "very large" to mission trainers. In this way the full range of trainer types is distributed across the COCOMO standard sizes for software development projects.

Table 11. Basic COCOMO Estimates for Standard-Size Products

	Small	Intermediate	Medium	Large	Very Large
Effort (MM)	2 KDSI	8 KDSI	32 KDSI	128 KDSI	512 KDSI
Organic	5.0	21.3	91	392	
Semidetached	6.5	31	146	687	3250
Embedded	8.3	44	230	1216	6420

Next the software development mode must be selected. The mode concerns the programming environment in which the software development team works. It is classified as "organic", "semidetached" or "embedded". The typical software development effort in a training device vendor's plant appeared to match the description of the "organic" mode. In this mode, relatively small software teams develop software in a highly familiar, inhouse environment. Most programmers connected with the project have extensive experience in working with trainer software and have a thorough understanding of how the software contributes to the trainer's performance. Project people can contribute to the project design in its early stages, without extensive communications overhead. There is a stable development environment with a minimum need for innovative data processing architectures or algorithms and relatively low premium on early completion of the project. While other modes of software development may be appropriate for certain projects, the cost tables in this report are based on the "organic" mode.

In the next step, SMEs rate the various instructional features according to the estimated complexity of the development effort. The most frequent SME rating for each feature is used. The ratings include "very high" (VH), "high" (H), "medium high" (MH), "medium" (M), "low medium" (L'), and "low" (L). At this point in the process, a working table is developed for projecting man-months. The man-months of effort for the size task being undertaken is read from Table 11 and recorded. Next the number of features available for each of the complexity levels is noted. Then man-months are distributed equitably across each of the complexity levels. Table 12 represents a working table for projecting the man-months required to estimate the development costs of each feature. Man-months are then converted to man-hours using the COCOMO standard of 152 working hours per man-month. This number is then converted to dollars using the U.S. Department of Labor wage rate for a software support engineer.

Table 12. Man-Month Projections for Fidelity Dimensions

Rating	MM Factors	X	Number of Features	=	Man-Months
VH					0
H	10.27		1		10.27
MH	9.77		2		19.54
M	8.27		1		8.27
LM	7.77		3		23.31
L	7.27		4		29.08
			11	=	99 MMs

Note: Fidelity Features were identified under the Organic Mode/Medium sized product, reflecting 91MM of effort, COCOMO Model.

Fidelity Dimensions. The OSBATS model requires cost values for major components of the simulator such as the visual system, motion platform or seat motion, sound simulation and map area. The approach used to create cost factors for these features was similar to that used for instructional features, which was to use a special application of the COCOMO model. In this instance two cost factors are required for each fidelity dimension, a maximum cost (for maximum fidelity) and a minimum cost (for some minimum level of fidelity). The OSBATS model automatically extrapolates from these figures to obtain the cost for other levels of fidelity. Specific fidelity dimensions requiring cost values are described earlier in this report.

Without repeating the detailed application of the COCOMO model described under "Instructional Features," the major steps

in estimating the cost of simulator capabilities at minimum and maximum fidelity levels are as follows. First, the cells of required data are identified (i.e., cost of two levels of fidelity for 11 simulation dimensions). Next the mode of software development is selected as "organic". This is followed by SMEs rating each feature according to complexity (i.e., very high (H), high (H), medium high (MH), medium (M), low medium (LM), and low (L)). Man-months of programming effort for the total project is read from Table 11 as adapted from the COCOMO handbook and a prorated share of these man-months is assigned to the development of each simulator feature based on the complexity of each feature. Man-months per feature is transformed into dollars per feature. Each dollar figure was spot checked against available data such as lines of code or actual contract costs for procuring the feature at that complexity.

Cost Data Verification. An attempt was made to compare COCOMO generated data on instructional features and fidelity levels against the historical records from contracts or proposals. Table 13 compares the COCOMO generated cost estimates for 14 instructional features for a typical OFT. Using the historic record of three OFT contracts and/or proposals the cost of each instructional feature was estimated. Lines of code information were available for the T-45 and MH-53 OFTs. Values were calculated using an industry based cost of a man-month of programming services and standard lines of code per man-month. In the case of the AH-64 CMS man-month data were directly available.

Table 13 indicates that the cost values generated by the COCOMO model are neither consistently high nor consistently low. More important than the actual values generated by the model is the ranking of the instructional features. Overall those features costing more on the T-45 OFT (e.g., tutorial, scenario control, record/replay, performance measurement) are also the more expensive COCOMO features. The difference in the costs of the instructional features on the different trainers could be in the complexity of software development. Since the COCOMO estimate is for an instructional feature requiring a moderate degree of programming, the costs generated by the COCOMO model should be middle-of-the-scale values.

Table 14 displays the COCOMO generated cost estimates for the fidelity dimensions in the OSBATS model. Cost data on the motion system and sound effects on the T-45, MH-53E, and the SH-60F were estimated from the lines of code required to produce the dimension. The cost values generated by the COCOMO model tend to exceed the costs provided by the contracts. The difference in the costs of the fidelity dimensions are probably in the software's complexity.

Table 13. Comparison of COCOMO and Program Estimates of Instructional Features

Instruc. Feature	COCOMO	<u>Program Estimates</u>			
		T-45	OFT*	MH-53	OFT* AH-64 CMS+
TUTORIAL	12	25			
SCENAR CNTL	12	34		8	
INIT COND	6	9		8	8
VARS CNTL	6				8
MLFCN CNTL	11	14		8	8
IOS DSPLY	10	12			7
PROC MNTR	6	11		8	4
SYS FREEZ	6	2		4	
PARAM FREEZ	8			8	6
RECORD/RPLY	11	25		19	28
PERF MEAS	12	21			
HARDCOPY	10	3		8	3
REMOTE REPLAY	11	2			
DATA ANAL	15				

* Based on LOC + Based on Man-Days
All values in thousands of dollars.

Table 14. Comparison of COCOMO and Program Estimates of Fidelity Dimensions

Fidelity Dimension	COCOMO	<u>Programs with SLOC Estimates*</u>			
		T-45	MH-53E	SH-60F	TPDC
VISUAL:RES	26				
VISUAL:CONT	26				
VISUAL:TXTR	26				19
VISUAL:FRONT FOV	35				
VISUAL:SIDE FOV	35				
VISUAL:F/X PNTS	26				19
VISUAL:F/X AREA	28				
MOTION:PLTFM	37	24	18	73	
MOTION:SEAT	30	13			
SOUND F/X	28	17	8	8	12
MAP AREA	28		26		

Note:

1. For OFT - software only
2. Visual systems considered minimum fidelity

* All values in thousands of dollars.

Tank Turret Maintenance

Although the primary emphasis in this data collection effort was on rotary-wing operations, a preliminary fidelity survey was performed on the M-1 Turret Organizational Maintenance Troubleshooting Trainer (TOMTT) at Fort Knox in order to identify possible data constraints imposed by the application area selected by the OSBATS model developers. A Training Device Capability Survey was completed on the TOMTT at the Turret Maintenance School.

There were several notable differences between the simulation configuration for an operations trainer (AH-1 Apache) and a maintenance trainer (M-1 TOMTT). The operations trainer requires a large investment in visual simulation fidelity, whereas the maintenance trainer requires a large investment in physical/functional fidelity. Numerous tasks in rotary-wing operations seem to depend upon the initiation and sustainment of motion cues. Motion cues are not important in maintenance training. Aural cues, however, are as important in maintenance training as in operations training.

In order to expand the design of trainers into the maintenance domain, considerable development of the concepts of physical and functional fidelity is required, and additional work is required in the area of cost effectiveness.

Data Source Evaluation

Data to run OSBATS are available. However, acquiring the majority of the elements requires a substantial investment of resources. The reports, reviews, and bibliographies investigated provide evidence that the required detailed data elements are not easily available in the literature. Until and unless research aimed at the specific relationship between tasks taught on training devices and the fidelity required to train these tasks effectively has been conducted and published, the data must be generated through interviews with SMEs, contracts, and direct observation. In fact it is quite realistic to assume that much of the information required will continue to be collected in this manner, with research only serving to verify and validate selected portions of the information. The following section describes the difficulties of collecting resident data required by OSBATS.

The resident data are used by the OSBATS tools to generate a possible delivery system that can provide the training required. As noted in Table 1, the training device fidelity dimension capabilities and instructional features data are used in three tools: simulation configuration, training-device selection, and resource allocation. The device cost data are used in all five of the OSBATS modules.

Fidelity Dimensions

Identifying the current fidelity dimensions and levels on the Army training devices at Fort Rucker was not difficult. However there were some difficulties encountered when coding the information from the Training Device Capability Survey into the computer format required by the model.

The current definition of Visual Resolution used by OSBATS is not adequate for collecting data. Assessing an object's discriminability at a particular distance requires a considerable amount of subjective opinion on the part of the training analyst collecting the data. In addition, visual systems generated using computer generated images are usually discussed in terms of arc minutes, luminance, contrast, and color, not distance. Also, the sensor units are distinguished in terms of degree of magnification. Finally, requesting the SME to provide the information often leads to the judgement being based on performance parameters, not learning requirements. The orientation of this dimension should be altered to accommodate variations in arc minutes, luminance, contrast, etc. required for presenting necessary learning stimuli. This would require re-structuring the current Fidelity rule set and reorganizing both the existing information and the collected, as yet unstructured information.

Without a photographic representation of what constitutes "low", "medium," and "high" density hydrographic and cultural features, the definition of Visual Content also requires a considerable amount of subjective judgment on the part of the training analyst. The photographic approach being suggested by Kincaid, Andrews, and Gilson (1987) could alleviate a large degree of the subjectivity inherent in this item. In addition, since OSBATS has all fidelity features arranged into a seven-step scheme, visual systems dimensions must be forced into this limited group of options. Most of the larger visual simulation designers have a library of visual elements available for use in different systems. Therefore the cost in different visual content would be associated with some factor other than the type of features in the background.

The coding format for Visual Texture does not adequately describe the range of texturing techniques currently available to engineers. For example, a very realistic picture can be designed using a cell texturing technique. This technique increases the realism of the scene without increasing the cost. In addition, there is no option for coding computer generated images. The last three levels of Visual Texture (different degrees of digitized photographs) are several years away from actually being used by the Army in visual simulation.

The only flight simulator evaluated at Fort Rucker that had an out-of-cockpit visual system was the Cobra (AH-1 FTS). The Front Field-of-View for this helicopter was 48 degrees horizontal and 36 degrees vertical. Neither the precise vertical nor precise horizontal dimension was listed on the data collection sheet. In addition, the cost of field-of-view is influenced by the means by which the field-of-view is displayed. A wider field-of-view is possible by using a rear projection camera and front screen, which is a low technology. The manner in which the scale has been developed implies that a larger field-of-view is automatically associated with a more expensive system. Thus the real scale and cost are confounded.

The comments on Side Field-of-View are similar to the ones expressed for Front Field-of-View, the dimensions are limited and arbitrarily grouped. The need for a right side window display, and the size required for the display, should not be connected with the size of the left window display. For Rotary-Wing operations, in most cases the left window display is far more important in tasks requiring that the pilot practice hovering and landing tasks. The right window display is important for providing peripheral cues related to forward motion. In most cases a smaller right window display would be task appropriate.

The difficulty with the Special Effects dimension is that the effects in the background scene have been arbitrarily grouped into packages. This places a responsibility on the training analyst collecting the data to accurately place the scene viewed into the proper category. In addition, the scene requirements appear to be mixed. The occurrence of cultural lights implies the need for a dusk/night visual scene, while the effects that follow cultural lights in the packages could be implemented using a day visual scene. Coupling Special Effects with day/dusk/night visual scenes should be avoided by separating out the requirement for night scenes or day scenes, that is by using a cleaner taxonomy.

For Motion Degrees of Freedom, coding is limited to degrees of simulator movement. Both the fidelity and the cost could also be influenced by the range of platform movement. Thus the Motion dimension also suffers from an incomplete consideration of costs and fidelity. Not considered is the cost of implementing adequate motion models for representing the functional fidelity required for training.

The coding format for Seat Motion assumes that the motion effects are cumulative. It is not clear that this is a good assumption. According to this format there would be no occasions where a task would require a g-seat without also requiring a seat shaker. Design dependencies like this should be avoided, perhaps by dealing with them as independent fidelity dimensions.

The Sound Effects coding scheme does not appear to be an accurate description of increasing complexity in sound effects. It is another case of inserting design dependencies into the data collection phase. From the Fort Rucker visit, the sound effects for the UH-1 CPT would have to be coded "4" indicating that the simulator was designed with normal operating sounds, abnormal operating sounds, weapons effects, and skid noise. However the sound effects were limited to normal and abnormal operating sounds. There were neither weapons sounds nor skid noises on the device. In addition, one of the instructors questioned the inclusion of failure sounds, his comment being that some failures do not necessarily produce a sound, instead the engine quits, which is an absence of sound.

Map Area was described in terms of kilometers, miles, and nautical miles in the different operator manuals. Conversion tables or routines would need to be built to use these data. In addition, Map Area is not necessarily limited to a visual system, as the OSBATS model definition states. Any navigation training exercise requires a gaming area for the navigational checkpoints. Also the range of sizes was limited; large scale gaming areas for tactical training could easily cover several hundred miles. There may be other factors involved, such as the density or complexity of the area represented; or the need to map actual locations versus using artificially generated areas.

Technical Performance Levels

Decimal values have been assigned to each of the fidelity levels by the model developers. These decimal values represent a performance scale based on the number of levels within each fidelity dimension. The OSBATS model uses these technical performance values whenever fidelity dimension and level decisions are being made. The decimal value assigned to a fidelity level depends upon the number of other levels in that fidelity dimension. Use of normalized scale values to make fidelity optimization decisions makes it difficult to add levels to an established dimensions. In order to increase the number of fidelity levels, the decimal values of all the levels within that dimension would have to be recalculated and the expert system rules would have to be changed to generate these new values. This requirement also makes it difficult to add new dimensions to the model.

Instructional Features

As with the fidelity dimensions, the documentation of the instructional features available on current training devices has not been difficult. Operator manuals, when they were available, proved to be a better source of information on instructional features than did the simulator operators themselves. Several issues arose while investigating instructional features.

The instructional features configured on the training device should be defined as independently as possible because specifications for features differ by contractors. Extreme caution should be used in comparing a feature on one device with a similarly labeled feature by a different contractor. This problem is compounded when one feature may be subsumed by another feature, such as data analysis and performance measurement.

The instructional feature literature and examination of the training devices at Fort Rucker suggest many ways to design and implement instructional features. The current OSBATS model documents the occurrence/absence of an instructional feature on individual training devices and the estimated cost associated with the feature, yet it does not account for the range of feature configurations possible, like it does for fidelity levels. Levels of Instructional Features are required with a corresponding cost curve in order to adequately develop and recommend cost-effective Instructional Feature packages.

Instructional Feature Benefit Weight

This value represents a task independent measure of the frequency of use of an Instructional Feature (see Polzella, 1983). This value is generated from instructor assessments of the Instructional Features available on the trainers with which they are familiar and from the training research for features not found on Fort Rucker helicopter simulators. Since frequency of use of an Instructional Feature can be altered by proper training, this is probably a weak value or indicator, and should be used with caution to assign Instructional Features in the design of training devices. Instructional Features should be selected on some effectiveness basis, for example the potential savings in overhead time incurred through the use of the Instructional Feature. This would reflect the time lost to training while the instructor performs non-training tasks, i.e., repositioning the trainer to continue an interrupted exercise. Another factor might be the effect the Instructional Feature had on the learning of the task.

Training Device Costs

The device cost information (i.e., investment, variable, fixed, etc.) required for the OSBATS model is not readily available from contracts and must be estimated using subject matter experts. However the format used to generate the cost data for this report is sufficiently detailed to allow independent verification of all estimates/calculations.

Fidelity dimension costs are not readily available in the detail required by the OSBATS model, therefore a cost estimating relationship was used to generate cost figures for this dimension. Minimum and maximum costs by device are artificial to

the extent that several of the upper fidelity levels are not currently being produced or are only conceptual. Because of this the documentation of the procedures and data used to generate the cost data should be made available within the system so that the origins of the costs can be examined by OSBATS users.

Instructional Feature costs are not available in the detail required by the OSBATS model, therefore a cost estimating relationship was also used to generate cost figures for this dimension. Documentation of the steps used to generate the costs should be made available so that the origins of those costs can be examined by OSBATS users.

Cost data on Fidelity Dimensions and Instructional Features doesn't appear to have been accumulated in any systematic manner by any of the services. Contractors are reluctant to share cost information because of the competitive arena in which they operate. Contractor cost proposals seldom provide estimates for generating lines of code or hardware cost used in the cost estimating relationships for the individual factors. In addition, contract costs are quite questionable, without knowing the rationale and acquisition strategies that led to the negotiated prices, especially if the product is delivered in lots. Finally, there are endless engineering changes and design modifications that distort or totally destroy cost-to-feature relationships that might be drawn from contract information.

Without actual (and reasonable) contract costs for the individual Instructional Features and Fidelity levels, the only documentable approach for generating cost data is through cost estimating relationships. However, even those relationships are not constant. Within the next few years the methods used for developing instructional features and fidelity dimensions could change drastically. Through state-of-the-art computer generation techniques, digitizers, and computer aided software engineering, Software Engineers would no longer be required to develop lines of code. Instead code would be generated using a computer. This technique could reduce the development costs, increase the ease with which modifications could be made, and remove the only variable currently able to provide cost information, i.e., lines of code, for instructional features and fidelity dimensions.

The issues of reliability and validity of cost factors deserves special attention. Those cost factors generated by SMEs from historic data must be treated separately from the cost factors generated by the use of cost estimating relationships. Expert judgment and sample data from contracts and proposals have been the basis for estimating certain of the cost factors. Included are investment cost, fixed cost per year, variable cost per hour, life-cycle, and utilization hours per year. If reliability is defined as the degree to which different cost analysts independently arrive at the same value for a cost

factor, then reliability of these cost factors cannot easily be determined. The technique used to generate these cost estimates was a hybrid group consensus technique. The process involved asking one expert to assign a value to a cost factor and then requesting other experts to adjust the estimated values accordingly. The different judges did not each provide independent estimates.

Agreement on the cost data for instructional features and fidelity dimensions should be higher than for the other cost factors, because there are fewer areas in which individual judgment can enter into the process. The COCOMO model was used in this effort to generate the cost values for Instructional Features and Fidelity dimensions. However even with use of the COCOMO model there still remain many opportunities for experts to differ in how they carry out the steps in the process. Judgments are required of the cost analysts as to the standard size product produced, the type of programming effort required, the complexity of the task, and the distribution of available person-months of labor across programming tasks.

A second aspect of the costing process is whether the cost values generated are valid; in other words, do the cost values generated accurately reflect the cost of the feature or dimension. One method which can be used to assess the validity of cost data is to compare the generated data against whatever historical data are available. This method of spot-checking the validity of the cost estimates was used (see Tables 13 and 14). The results of this spot check indicate that there are no "true" costs for a Fidelity dimension or Instructional Feature, but there is a range of values. For our purposes, the COCOMO estimates were considered valid if they fall within the range of historic data on the cost of a feature.

The usefulness of the cost factors in projecting the cost of alternative forms of simulation goes beyond the issues of reliability and validity. Other important issues emerged and are discussed below. The issues and observations presented here reflect the insights gained in collecting and processing cost data, and a special awareness of the problems related to the quality and availability of these types of data.

The present OSBATS cost factors do not make possible detailed cost modeling. Within OSBATS the cost factors are estimates of the general performance of vendors in terms of skill, efficiency and innovation in producing simulators to meet requirements. Vendors vary significantly in skill, efficiency and innovation, and therefore in actual production costs. Also at the time that OSBATS is used in the simulator development process, only broadly defined features of the required simulator are described. The range of possible costs for a single feature may exceed the difference in costs among many of the features.

In this environment, the best that can be done is to represent general tendencies of cost. As evidence of the increasing investment in visual fidelity, a contract was let to Evans and Sutherland (No. N61339-88-C-0038) on 15 April 1988 to provide visual simulation for two 2H113 AH-1Ts for \$16,784,000. This figure exceeds the estimates generated by the COCOMO model using the selected parameters, as well as previous historical data on visual simulation.

The level of precision in estimating costs required by the OSBATS models remains unknown. Presumably precision varies by the type of cost factor. To study the requirement for precision in individual cost factors, a sensitivity analysis needs to be performed. Until this analysis is performed the general rule of thumb given by the model developers is that two significant figures is adequate.

Are there practical alternatives to labor intensive data collection? Collecting or generating cost data can become prohibitively expensive if the level of precision is allowed to shift with the availability of data or funds to support data collection. The technical challenge to become increasingly more accurate or representative will lead to ever more expensive data that far exceeds the resolution of the OSBATS model. The solution to holding down costs in cost factor collection is to use cost estimating relationships, and to routinely spot-check the validity of the cost factors generated in this manner.

Database Management System

This section of the report describes the development of the Database Management System (DBMS) for handling the data elements for the resident database and the rule formats necessary for the OSBATS model. The DBMS was designed to provide the OSBATS user access to the database through a series of easy to follow menus.

The database supports the five modules of OSBATS in an minimally integrated fashion. These modules were developed and delivered to ARI incrementally by the Human Resources Research Organization (Sticha, P. J., Blacksten, H. R., Buede, D. M., Singer, M. J., Gilligan, E. L., Mumaw, R. J., & Morrison, J. E., 1988). Due to this incremental development path, the programmers chose to utilize a flexible analysis and design methodology for developing the DBMS. The first step in this methodology was to study the "C" language code in which the module is implemented as well as the ASCII data files used by OSBATS to determine the data input requirements. The results of this analysis were compared to previous analyses to identify data redundancies or conflicts (Engineering & Economics Research, 1987). The resulting list of data elements identified all the elements required by that version of OSBATS.

From an early stage of the project it became obvious that there were conflicting data requirements that needed to be reconciled before the DBMS could be developed. The first requirement for the database is that regardless of how the data are stored, the extracted data must be in precisely formatted ASCII files in order for OSBATS to use it. The OSBATS data are arbitrarily sorted across files and ordered within files. In none of the documentation (e.g. Sticha, Singer, Blacksten, Mumaw, & Buede, 1987) is the order of the individual data files described, nor do the files provide a means of tracking the data across files. The second requirement has to do with organizing the data within the database for efficient, reliable storage, access and modification.

A fourth generation database management system language was chosen because of these conflicting requirements. FOCUS (Information Builders, Inc.) was selected as the language of the database for four reasons. First, FOCUS supported the changes in the model coding and database design as a result of the evolving OSBATS model. Second, the FOCUS hierarchical data structure is faster in execution than most competing relational database management systems. Third, it is the DBMS of the Training and Performance Data Center (TPDC). It is anticipated that TPDC will become more directly involved in gathering and storing data required for the OSBATS model. A common DBMS language would facilitate the data transfer from TPDC to the OSBATS project. Fourth, FOCUS is capable of reading a variety of commercial

databases so that if different database management systems are required in the future, the transfer would be facilitated.

Database Development

In a hierarchical data architecture, data elements are arranged according to their hierarchical relationships. Using FOCUS, it is possible to quickly define the data elements and the relationships among them in order to create the database. FOCUS also has the capability to incorporate built-in or user defined checks on the data to assure data integrity. Its most useful feature is that FOCUS allows the database structure to be modified relatively easily. This has been an extremely useful feature due to the evolving nature of the OSBATS models.

The data definition facility of FOCUS that allows the data fields and the hierarchical relationships among them to be defined is stored in a file called the "FOCUS Master File Description." While executing, FOCUS programs read this master file and use the information contained within to manipulate the actual data items in the database. Appendix F contains the actual master file description of the DBMS. In this listing, comment lines are preceded by \$ signs which explain and highlight the FOCUS data elements and corresponding OSBATS flat file names.

Presently all five modules of the OSBATS input data through a common data input module. This enabled the programmer to address OSBATS' need for flat files and the DBMS' need for a hierarchical structure. The data exchange interface developed to deal with this situation allows the OSBATS model to call for a data elements by name without knowing the corresponding formats, files, and names or layouts within the files from which the data elements were retrieved. This data exchange interface has enabled the programmer to accommodate the evolving OSBATS models.

The early OSBATS model read input directly from about twenty different ASCII files. In the read procedure originally provided with the model, every data item to be read required that detail be hard coded into the read procedure itself. For example, direct reads required information about which field the item was to be found so that the file could be opened for reading. It also required precise descriptions of the format of that element (i.e., how many total digits or digits after decimal point) and its position with respect to other data elements within that data file. These hard coded read procedures gave rise to several problems. First, if the data requirements of the model changed in any way, a C language programmer had to recode the read subroutines to accommodate this change. If a data item was no longer needed, there was no way to just delete it from the data file without affecting the read code for all other data reads from the same field. Recoding was also necessary if the data item changed from ten to twelve digits.

Because of these limitations, an interface between the model and its data input procedures was developed by Engineering and Economics Research, Inc. (subcontractors on this effort). This mechanism allows the data to be called by the model in the form the model requires, without knowing where it was stored. This separation also allows the database designer to arrange the number and layout of the output files to meet other needs, without adversely affecting the model.

This data exchange interface, which has been integrated into the OSBATS model by HumRRO and PAR, allows the database and the model to evolve independently of each other yet support each other without much disruption and with a minimum of re-programming. The data exchange interface operates through the use of a data dictionary which is internal to the interface. As long as the interface is aware of the models needs and the physical location of the data in the database, either the model or the database or both may change without causing any problem to each other. Changes are made in the interface by altering a line of text in the internal data dictionary. Figure 1 displays the data exchange interface and its relationship to the database.

Evaluation of Prototype Database

At the present time, the database management system and the database file structure are in final form, as far as the data requirement for the current OSBATS model is concerned. The current OSBATS database was designed to deal with one specific weapon system at a time. For each weapon system the database contains five categories of data, as described earlier in Tables 1, 2, and 3.

The database administration programs (24 separate FOCUS procedures) allows the standard range of database maintenance tasks (data entry, modify, deletes) to be carried out by the users. The reporting procedures produce the 17 ASCII flat files which are postprocessed by the Data Exchange Interface for use by the OSBATS model. Figure 2 depicts the data architecture used within the database. Standard testing of the database management system was done using the data provided by HumRRO. All the add, delete, and modify procedures were tested and the database works correctly for the test data.

One rather critical area that could not be addressed in this effort was to devise a mechanism to put data generated by OSBATS back into the database. This a vital and non-trivial task and would require changes to how the model outputs data.

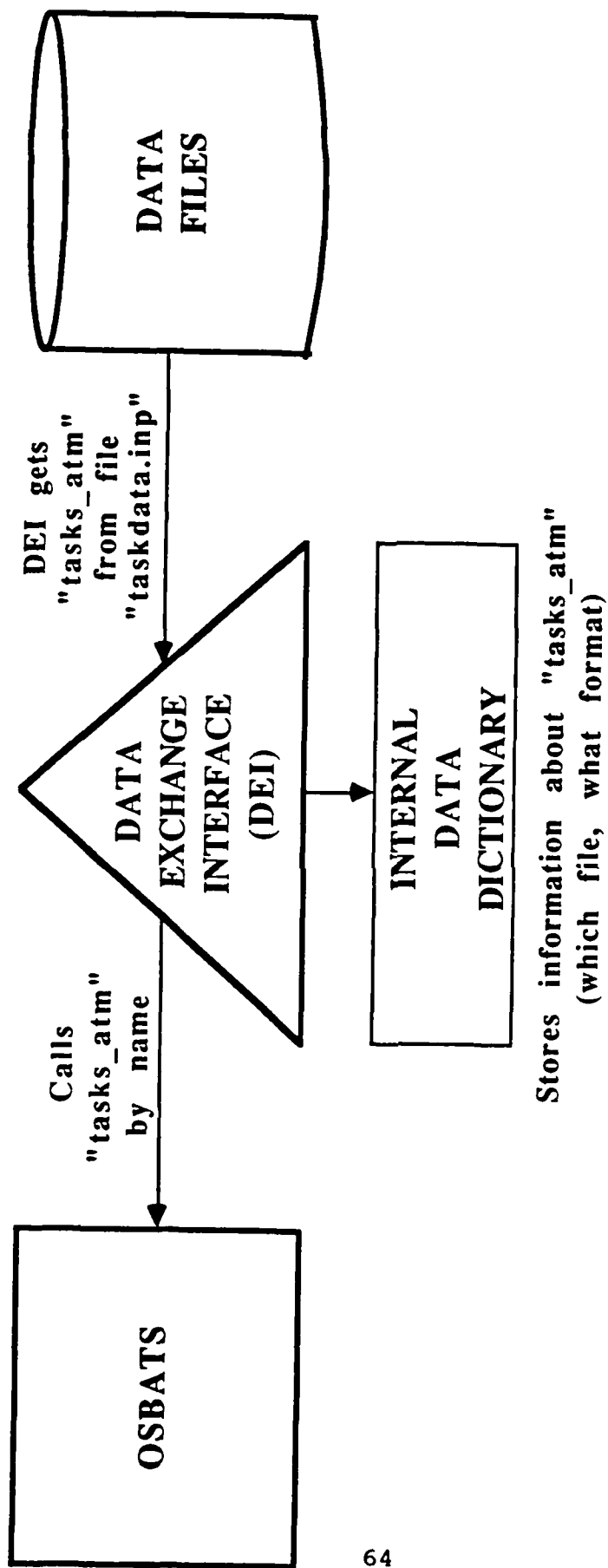


Figure 1. Data Exchange Interface

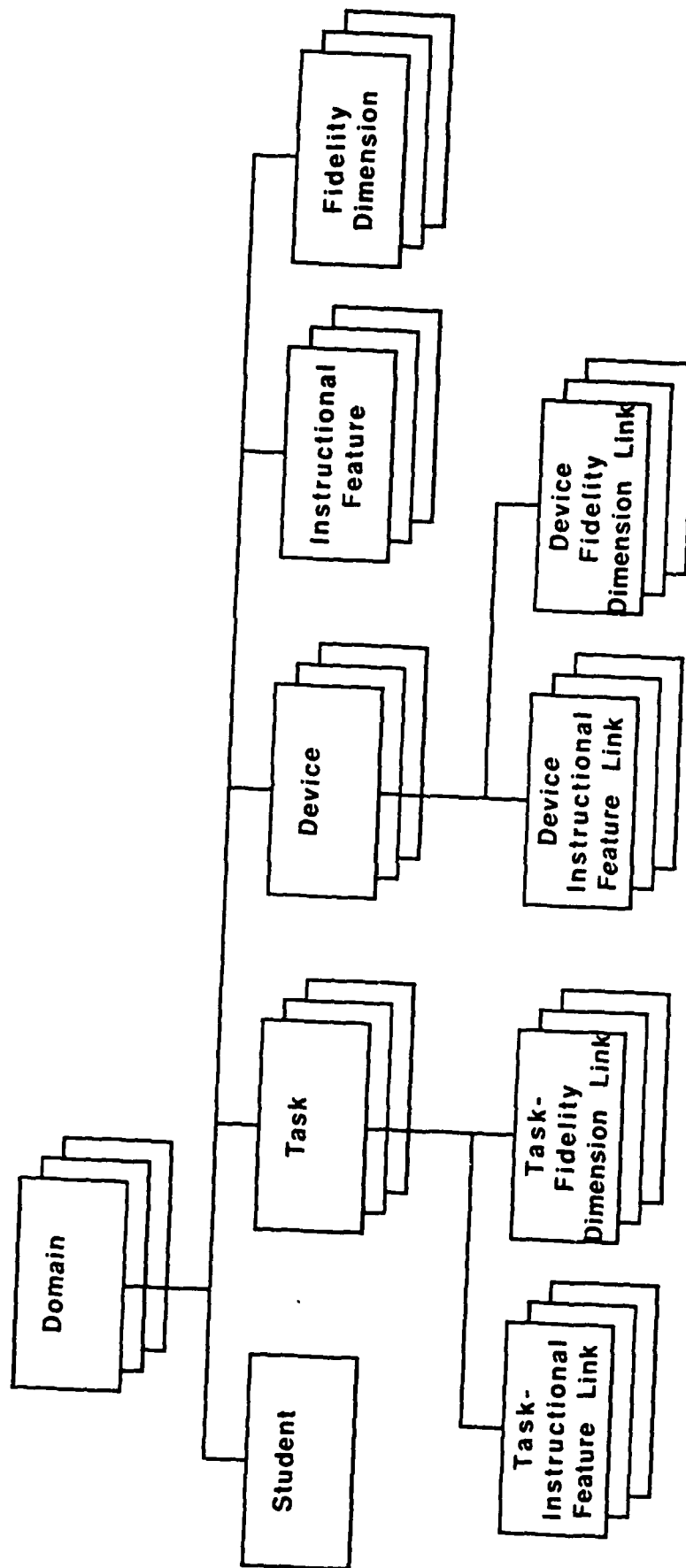


Figure 2. OSBATS Database Structure

As mentioned above, at present the data generated for and by OSBATS are saved in flat ASCII files. These files are uniquely identified by their names and by storing them under known (and OSBATS created) subdirectories. Although limited to saving only one set of data, this technique may form the basis of a data saving mechanism by the DBMS. For example, instead of using numerous data files spread over many directories, OSBATS could produce one or two files in one known directory. Data elements in those files would be tagged to indicate which data set it belongs to or even time stamped to indicate some specific instance of data. The DBMS would then store these data (including the extra identifying information) and retrieve the specific instance of data required. Note that through the use of ownership and time tags, several instances of the same data could be saved and correctly retrieved.

Presently there is password based security feature present for the database that prevents access to the entire database by unauthorized users. If necessary, this protection scheme may be modified to protect groups of data elements (task or resident data). This will preserve integrity of sections of the database and allows user to change other parts at will. At present users will be given a copy of the entire database (a FOCUS data file) and will be free to modify any part of the database copy, although this would require having a licensed FOCUS DBMS program.

Database Recommendations

During the implementation of OSBATS, some very important lessons were learned. In this section some of the problems that surfaced are pinpointed and suggestions on ways to rectify them in the future versions are presented. OSBATS is a fairly complex software system that draws from at least three different subsystems: namely, the OSBATS model written in C language, that is not integrated with a (FOCUS) database management system and uses external calls to an expert system shell (EXSYS).

FOCUS. Due to the complexity of the total system, it was inevitable that at this prototype stage integration and performance problems would surface. There are several possible causes and remedies for some of these problems. We will focus on the two supporting subsystems, the database and the expert system components.

As has been mentioned before, data needed by OSBATS model can be stored in the developed FOCUS database, which is a separate environment from the OSBATS model. To retrieve the data stored in the database, the user needs to invoke FOCUS and run the FOCUS report generation procedure which creates ASCII files containing most of the data needed by the OSBATS model.

The user then must exit FOCUS in order to run OSBATS. OSBATS then reads all those data files through the data exchange interface and uses the data. Similar environment switches between FOCUS and OSBATS ("C" environment) might be necessary if data generated by the OSBATS model needs to be put back into the database, although at present there is no mechanism for doing this.

Clearly, both the environment switching and exchange of data through ASCII files slows down the entire operation and is an irritant which reduces the user friendliness, thereby downgrading the possible usefulness and acceptance of the system. One solution is to eliminate the ASCII intermediate files altogether which would eliminate the need for any environment switching. This could be done through the use of a FOCUS utility called FOCUS "Host Language Interface" would be used to integrate the developed OSBATS model with the needed database.

The FOCUS system should still be used for interactions requiring only standard data base administration functions (i.e. add, delete, modify data). Data retrieval calls should be embedded into the OSBATS model, or more specifically, within the data exchange interface procedures. The FOCUS Host Language Interface would then enable the OSBATS model to directly reach into the FOCUS data file and retrieve data without any need for intermediate data files or switching from OSBATS "C" environment to the FOCUS environment. Through the use of the Data Exchange Interface there will only be a minimum amount of change needed in either the model or the DBMS to incorporate the above mentioned modification. It would only be necessary to replace the data read (write) procedure in the Data Exchange Interface with the calls that come with the FOCUS Host Language Interface.

The benefits of embedding database calls into the OSBATS model through the use of a FOCUS Host Language Interface are:

1. Eliminate the need for intermediate data files for data exchange,
2. Speed up data retrieval process,
3. Allow data to be put back into the DBMS,
4. No time consuming environment switches will be necessary.
5. Allow a context sensitive help system to be built-in.
6. Allow access to an on-line data dictionary without leaving OSBATS.

These changes will give the model a uniform and flexible mechanism to retrieve or deposit data to and from the current database, as well as make the system more user friendly.

With the current interest in SQL oriented relational DBMS, the design of the current database was carried out with the possibility of future conversion into a relational database. Even though FOCUS supports hierarchical structure, the way the current database is structured, it will be a very simple task to split the combined hierarchical database structure and add a few extra link fields (to maintain the hierarchical information) and convert this into a relational design. For example, task data and instructional feature link data for a task are linked by a hierarchy in that every task data element has several instructional feature links that belongs to it. In FOCUS, this hierarchy is declared in the FOCUS master file and is maintained implicitly through FOCUS pointers. To convert this section into a relational structure, two tables need to be created, one for the task data and one for the instructional feature link data. To maintain the hierarchy information, the instructional feature link data table would be given an extra field that holds the identification of the task to which the instructional feature link belongs. This process of splitting up of the hierarchy and use of explicit data fields to maintain the hierarchical information would have to be carried out at every node of the database.

However, before converting this DBMS into a relational one, it must be pointed out that actual data almost always shows some kind of hierarchy. To impart this kind of structure into a relational system requires extra information (the fields mentioned above), therefore a relational DBMS for a data set that comprises a natural hierarchy takes up more space than a comparable hierarchical design. Also since most modern fourth generation (non-procedural) database languages (relational or hierarchical) offer similar capabilities, means that FOCUS is just as good or an even better choice for this project.

The need for rapid prototyping in a project of this sort can not be stressed enough. As the design of OSBATS evolved, its data requirements changed. These changes then had to be directly translated into changes in the database design. Additionally, the design decisions of the database also affected the design of the model. This close coupling of the two systems meant that the design process had to be highly iterative. This also meant that changes to the database had to be made quickly and reliably, and the rapid prototyping facility allowed just that.

EXSYS. The second major OSBATS subsystem is the expert system shell. A stand alone expert system shell called EXSYS is presently used for producing the task-instructional feature link table (an ascii file named table9.inp) and the task-fidelity

dimensional link table (an ascii file named cuersp.inp) that are used by OSBATS. To create these tables, a knowledge base of rules and facts were created using EXSYS editor. At the OSBATS startup, EXSYS is run to create the ascii files to be used by OSBATS. These files are actually EXSYS output report files. If the tables have been created for an earlier run, running EXSYS a second time is not necessary, an option provided for in OSBATS. However, if the rules or facts were to change in any way, then the user would need to enter the EXSYS environment, edit the rules, and run EXSYS to generate new report files. If only the input data used changes, then the user must interact with the EXSYS rules in order to generate new output files for the OSBATS session.

The problem is again that one needs to switch environment between OSBATS and EXSYS. This slows down the entire operation of running OSBATS and reduces user friendliness. Other than speed, there is another serious problem with this approach. EXSYS uses a proprietary structure for both rule and data. For example, rules are coded in a special way using an indexing scheme that speeds up their use by EXSYS. This also means that the special rule editor needs to be used to create them and that a standard database cannot store them. Therefore, as long as a stand alone shell like EXSYS is used, the total integration of OSBATS, both from system and from the data storage point of view, cannot be achieved.

A solution might be to use an expert system shell that can be embedded within OSBATS so that no environment switching will be necessary. The system also needs to have a standard data and rule storage format that is known so that the database management system can support OSBATS data needs. An embedded expert system like NASA's CLIPS could serve this purpose. It would allow access to both expert system data and rules by the model and the database, while at the same time avoiding the delay and great inconvenience of environment switching. Interestingly, an embedded expert system shell could also support examination and changing of the knowledge base "on the fly" from within OSBATS, something that cannot be done with a stand alone expert system.

Conclusions and Recommendations

In general, the types of resident data required by OSBATS and collected under this contract are available. Most of the data can be obtained through interviews with SMEs, operators manuals, device acquisition or maintenance contracts, and direct observation. The majority of the data elements are objective measures. Those which are more judgmental (i.e., rules and costs) can be documented for examination.

Issue 1. A task survey format is a viable method of collecting data for developing expert system rules. However, the respondent's frame of reference is lost, and that may be essential for interpreting responses to the items. The use of the survey methods does provide a basic frame for writing rules for later evaluation by one or more recognized experts.

Recommendation: The development of validated expert system rules should proceed from the information collected using the detailed questionnaires. The best approach would be to use a single expert or small group structured interview to review and evaluate the prototype rules. The group interview of the questionnaire data would serve to promote discussion which leads to a consensus answer.

Issue 2. The visual fidelity dimensions currently used in OSBATS do not reflect the dimensions used by system designers in the specifications for visual systems.

Recommendation: Change the visual fidelity dimensions so that they are more in line with design specifications. A visual taxonomy along the lines suggested by Kincaid, Andrews and Gilson (1987) could be a useful beginning in identifying visual fidelity dimensions.

Issue 3. There are other fidelity issues currently not being evaluated in the OSBATS model, specifically the in-the-cockpit visual displays and an assessment of the physical or functional validity of the cockpit systems such as communication, fuel, flight, etc.

Recommendation: Data collection has begun on the needed additional dimensions. Until the OSBATS model is changed to accommodate an improved dimensional taxonomy, data collection should be continued and the information retained.

Issue 4. Examination of the instructional features on the training devices suggests that there are many ways to configure each individual feature, many of which may effect the cost of the feature. The OSBATS model requires a single cost value for each instructional feature.

Recommendation: Levels of complexity of individual instructional features (like the levels within the fidelity dimensions) are required with a corresponding cost curve in order to recommend cost-effective instructional feature packages. These can and should be treated like the fidelity dimensions, and also may require some taxonomic work. Analysis of the overall realm of Instructional Features has been conducted by Eagle Technology for the Army Research Institute (Contract No. N61339-86-D-0009-0003). Results of this investigation should provide further information for modeling the task/instructional feature relationship.

Issue 5. Simulator instructors are not a good source of information for assigning instructional feature benefit weights to instructional features. Responses to the survey were confounded by the instructor's lack of familiarity with the features in question.

Recommendation: Instructional feature benefits can and should be calculated based on the number of tasks for which they are judged appropriate by professionally trained experts, based on the savings in instructor time provided by the feature, or some other measure of effectiveness.

Issue 6. The cost data that can be collected or generated is measured ordinally. The OSBATS cost-benefit algorithms assume that the data are interval level measures.

Recommendation: A sensitivity analysis on the OSBATS model should be run to identify the level of detail actually required of the cost data in the model.

Issue 7. Collecting the cost data appears to be best accomplished through the use of cost estimating relationships due to a lack of historical data.

Recommendation: Emphasis should be placed on refining and expanding the use of cost estimating relationships to generate the cost data required by the model. A COCOMO type model should be created and calibrated for this purpose. Routines for generating investment and operating costs, as well as the cost of instructional features and levels of fidelity, could then be built into the OSBATS model itself. Implicit in this approach is the need to monitor and update the cost estimating relationships as the technology changes. A monitoring effort would be less expensive and labor intensive than collecting large cost databases.

Issue 8. OSBATS does not contain a complete data set (input and resident) for a single major weapon system. Without complete data on tasks and devices the model cannot be used to make recommendations. Therefore at the present time, it is not

possible to evaluate the usefulness of the OSBATS model for making tradeoff decisions.

Recommendation: Collect a complete task data set, including task and resident data, for a major aviation system such as the AH-1 or the AH-64, so that a working data set is available for simulation engineers and training system designers to evaluate.

Issue 9. The OSBATS model, FOCUS database, and EXSYS shell do not interact with each other because they are separate environments. At present in order to run OSBATS, the user must switch between environments, which is time consuming and frustrating to the user.

Recommendation: Rework the OSBATS program so that access to the database, rules, and rationale for the rules is supported from the OSBATS program. This may require embedding a compatible DBMS and expert system shell inside OSBATS, embedding OSBATS inside some DBMS or expert system shell, etc. The goal should be to make access to the entire system transparent and compatible for the user.

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APPENDIX A
TRAINING DEVICE CAPABILITY SURVEY

TRAINING DEVICE / SIMULATOR CAPABILITY SURVEY

Device Name: _____

Nomenclature: _____

Weapon System Supported: _____

1. Is the visual display used by the pilot or co-pilot or I/O?
(circle one)

2. Visual resolution? An object one meter square is visible at:

- | | |
|-----------------------|-----------------------|
| a. less than 3/10 km, | b. 3/10 km, |
| c. 1/2 km, | d. 1 km, |
| e. 2 km, | f. 3 km, |
| g. 4 km, | h. greater than 4 km. |

3. Visual content? Check all elements available.

ground plane	buildings	taxiways
sky	sheds	landing pads
trees (scattered)	highways	tarmac
trees (grouped)	fields	TV antenna
mountains	planes	mountain ranges
helicopters	lakes	tanks
fences	ships	

How many slow moving vehicles (i.e. ground vehicles) are displayed?

How many moderately moving vehicles (i.e. helicopters, small planes) are displayed?

How many fast moving vehicles (i.e. jets) are displayed?

TRAINING DEVICE / SIMULATOR CAPABILITY SURVEY

4. Visual imagery? The visual image is represented using:
- | | |
|-----------------------------|------------------|
| a. no visual system, | b. Symbology, |
| c. Symbology plus CGI, | d. CGI, |
| e. CGI (grainy photograph), | f. Terrain Board |
| g. motion picture quality, | h. actual scene |
5. Field of view? In degrees:
- | | | |
|-----------------|---------------|----------|
| a. front - | horizontal by | vertical |
| b. left side - | horizontal by | vertical |
| c. right side - | horizontal by | vertical |
6. Special effects? Check all effects available.
- | | | |
|--------------------|-----------------|---------------|
| sun image | clouds (broken) | tracers |
| moon image | overcast | ordnance |
| impact | stars image | thunderstorms |
| smoke | day | lightning |
| flares | dusk/dawn | rain |
| gun flash | night | 2D texture |
| occulting | haze | 3D texture |
| dust | fog | shadows |
| rotor wash | horizon glow | color |
| clouds (scattered) | contrails | other |
7. Platform motion?
- | | |
|---------------------------|---------------------------|
| a. no motion, | b. 3 degrees of movement, |
| c. 5 degrees of movement, | d. 6 degrees of movement, |

TRAINING DEVICE / SIMULATOR CAPABILITY SURVEY

8. Seat motion?

- | | |
|-----------------------------|---------------------------|
| a. no motion, | b. general seat movement, |
| c. special effect movement, | d. g-seat, |

9. Sound effects? Check all effects available.

- | | |
|---------------|--------------------------|
| none | normal operating noise |
| weapon firing | abnormal operating noise |
| skid noise | engine failures |

How many different engine failure sounds are simulated?

How many different weapon effect sounds are simulated?

10. How big is the gaming area in the visual system?
(in sq. km or miles)

TRAINING DEVICE / SIMULATOR CAPABILITY SURVEY

INSTRUCTIONAL FEATURES INFORMATION

TUTORIAL:

SCENARIO CONTROL:

INITIAL CONDITIONS:

VARIABLES CONTROL:

MALFUNCTION CONTROL:

INSTRUCTOR OPERATOR STATION DISPLAY:

PROCEDURES MONITOR:

SYSTEM FREEZE:

PARAMETER FREEZE:

RECORD / REPLAY:

PERFORMANCE MEASUREMENT:

HARDCOPY:

REMOTE REPLAY

DATA ANALYSIS:

TRAINING DEVICE / SIMULATOR CAPABILITY SURVEY
VERSION 2

Device Nomenclature: _____

Weapon System Supported: _____

Special Equipment Display: _____

1. Is this display used by the pilot or co-pilot or I/O? (circle one)

2. What company makes the display? A B C D E (circle one)

- A. Singer-Link "Image"
 - B. General Electric "CompuScene"
 - C. Rediffusion Simulation "Continuous Tone"
 - D. Rediffusion Simulation "NovoView"
 - E. Other (specify)
- _____

3. Level of visual imagery? (circle one) A B C D E F G H (see attached guide containing examples of image quality)

4. Field of view in degrees? ____ horizontal by ____ vertical

5. Map area in kilometers/nautical miles? _____ Sq km/nm

6. Visual resolution? A B C D E F (circle one)

- | | | |
|------------|-----------|---------|
| A. 3/10 km | B. 1/2 km | C. 1 km |
| D. 2 km | E. 3 km | F. 4 km |

7. Check all special effects available:

- | | | |
|---------------------------------------|--|---|
| <input type="checkbox"/> sun image | <input type="checkbox"/> clouds (broken) | <input type="checkbox"/> tracers |
| <input type="checkbox"/> moon image | <input type="checkbox"/> overcast | <input type="checkbox"/> ordnance impact |
| <input type="checkbox"/> stars image | <input type="checkbox"/> thunderstorms | <input type="checkbox"/> smoke |
| <input type="checkbox"/> day | <input type="checkbox"/> lightning | <input type="checkbox"/> flares |
| <input type="checkbox"/> dusk/dawn | <input type="checkbox"/> rain | <input type="checkbox"/> gun flash |
| <input type="checkbox"/> night | <input type="checkbox"/> 2D texture | <input type="checkbox"/> occulting |
| <input type="checkbox"/> haze | <input type="checkbox"/> 3D texture | <input type="checkbox"/> dust |
| <input type="checkbox"/> fog | <input type="checkbox"/> shadows | <input type="checkbox"/> rotor wash |
| <input type="checkbox"/> horizon glow | <input type="checkbox"/> color | <input type="checkbox"/> scattered clouds |
| <input type="checkbox"/> contrails | <input type="checkbox"/> other special effects | |

TRAINING DEVICE / SIMULATOR CAPABILITY SURVEY
VERSION 2

8. Check all of the types of scene content available:

<input type="checkbox"/> ground plane	<input type="checkbox"/> buildings	<input type="checkbox"/> taxiways
<input type="checkbox"/> sky	<input type="checkbox"/> sheds	<input type="checkbox"/> landing pads
<input type="checkbox"/> trees (scattered)	<input type="checkbox"/> highways	<input type="checkbox"/> tarmac
<input type="checkbox"/> trees (grouped)	<input type="checkbox"/> fields	<input type="checkbox"/> TV antenna
<input type="checkbox"/> mountains	<input type="checkbox"/> planes	<input type="checkbox"/> _____
<input type="checkbox"/> mountain ranges	<input type="checkbox"/> helicopters	<input type="checkbox"/> _____
<input type="checkbox"/> lakes	<input type="checkbox"/> tanks	<input type="checkbox"/> _____
<input type="checkbox"/> fences	<input type="checkbox"/> ships	<input type="checkbox"/> _____

How many slow moving vehicles (i.e., ground vehicles) are displayed?

How many moderately moving vehicles (i.e., helicopters, small planes) are displayed?

How many fast moving vehicles (i.e., jets) are displayed?

TRAINING DEVICE / SIMULATOR CAPABILITY SURVEY
VERSION 2

FIDELITY ANALYSIS

1. Identify systems in the cockpit with the following types of physical fidelity:

ZERO	LOW	MEDIUM	HIGH
(absent)	(drawing)	(representation)	(actual equip)

2. Identify systems in the cockpit with the following types of functional fidelity:

ZERO	LOW	MEDIUM	HIGH
(absent)	(gross)	(approximate)	(mimics)
	(similarity)	(similarity)	(actual)
			(equipment)

TRAINING DEVICE / SIMULATOR CAPABILITY SURVEY
VERSION 2

3. What tasks do you train on the simulator using each system?

APPENDIX B
DATA DESCRIPTION DICTIONARY

SHORT TITLE: COST:INVEST GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3a1 EXTENDED TITLE: Investment Cost
TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME: INVEST

TITLE DEFINITION: The dollar amount spent at a specific point in time for a simulator from initial conception through delivery, including initial training and facilities preparation.

POSITION DESCRIPTION: Training Device Data, Training Device Costs, Investment Cost

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert.

EXAMPLES: Obtaining cost data will require access to the front-end analysis, research and development, procurement, and facility budget expenditures which supported the simulator. Data must be adjusted for inflation.

MAIN PRODUCTS IMPACTED:

METRIC: Investment cost is represented in dollar amounts expressed to two significant places.

EMBEDDED TERMS: None

JOB AIDS: A checklist of items to be included in the cost and year incurred consisting of:

- o Front-end Analysis
- o Training
- o Research and Development
- o Facilities
- o Contracting
- o Acquisition
- o In-house construction

RULES: none

NOTES: Investment cost may be available in the Work Unit Information System (WUIS) File on the Defense Technical Information Center Data Base (DTIC).

ENTERED BY: Ruth P. Willis ENTERED ON: 15 May 1987

•

SHORT TITLE: COST:FIXED/YR GLOBAL CAT. NO: 3
LOCAL CAT. NO1 3A2 EXTENDED TITLE: Annual Fixed Operating
Cost

TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME: FXD_MUL

TITLE DEFINITION: The annual fixed costs of maintaining a simulator are those which occur even if no student training is conducted.

POSITION DESCRIPTION: Training Device Data, Training Device Costs, Annual Fixed Operating Cost

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert.

EXAMPLES: This data is obtainable from the simulator custodian.

MAIN PRODUCTS IMPACTED:

METRIC: Variable is represented in dollar amounts expressed to two significant places.

EMBEDDED TERMS: None

JOB AIDS: A checklist of items to be included in the cost will be provided including:

- o Labor cost of a maintenance crew per year
- o Lease rate of building using standard cost per square foot per year
- o Supplies/material consumed in scheduled maintenance per year
- o Configuration modifications only (not technology updates)

RULES: None

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 26 May 1987

SHORT TITLE: COST:VAR/HR GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3A3 EXTENDED TITLE: Variable Cost Per Hour
TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME: VAR_YR

TITLE DEFINITION: The Variable costs represent those expenses for maintaining a simulator that change as a function of student utilization.

POSITION DESCRIPTION: Training Device Data, Training Device Costs, Hourly Variable Operating Cost

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert

EXAMPLES: Simulator data is available from the simulator custodian. Calculating the component costs of this element for a particular simulator to the student-hour level will require access to student throughout data.

MAIN PRODUCTS IMPACTED:

METRIC: Variable is represented in dollar amounts expressed to two significant places.

EMBEDDED TERMS: None

JOB AIDS: A checklist of items to be included in the variable cost/hr consisting of:

- o Utilities
- o Instructor Salaries
- o Instructional Supplies
- o Unscheduled Maintenance
- o Student Salaries
- o Extra hours service added to a basic fixed service contract

RULES: None

NOTES:

ENTERED BY: Robert L. Reirwald ENTERED ON: 28 July 1987

OSBATS DATA ELEMENT DICTIONARY

09-29-87

SHORT TITLE: LIFE-CYCLE COST: GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3A4 EXTENDED TITLE: Life Cycle in Years
TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The projected useful life in years of the training device as estimated at the time of procurement.

POSITION DESCRIPTION: Training Device Data, Training Device Costs, Life Cycle

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert. Model User.

EXAMPLES:

MAIN PRODUCTS IMPACTED:

METRIC: Years

EMBEDDED TERMS: None

JOB AIDS: Industry standards manuals

RULES: None

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 10 Aug 1987

SHORT TITLE: UTIL GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3A5 EXTENDED TITLE: Maximum Annual
Utilization

TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The maximum number of hours the training device is utilized in one year.

POSITION DESCRIPTION: Training Device Data, Training Device Costs, Maximum Annual Utilization

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert, Subject Matter Expert

EXAMPLES: Policies addressing training utilization may be available at the training device site. Fort Rucker device utilization is based upon contracted hours of training minus hours lost due to equipment malfunction divided into actual hours training is conducted.

MAIN PRODUCTS IMPACTED:

METRIC:

EMBEDDED TERMS: None

JOB AIDS: A checklist of items to be considered when estimating training device utilization will be provided.

RULES: None

NOTES: None

ENTERED BY: Robert L. Reinwald ENTERED ON: 10 Aug 1987

SHORT TITLE: VISUAL COST: GOLBAL CAT. NO: 3
LOCAL CAT. NO: 3B1 EXTENDED TITLE: Visual Resolution
TITLE VARIATION 1: VIS RESLIN
TITLE VARIATION 2: Visual Resol.
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The maximum distance on the pilot's visual display at which an object one meter square can be discriminated from the background.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response Capabilities, Visual Resolution

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert. Engineering Specifications.

EXAMPLES: Resolution is not typically described in these terms; therefore, collecting this data is difficult and time consuming.

MAIN PRODUCTS IMPACTED:

METRIC: Visual resolution is measured using a 6-point scale that relates resolution to the maximum distance at which an object one meter square can be discriminated.

- 1 - Msq @ .3 kw
- 2 - Msq @ .5 kw
- 3 - Msq @ 1.0 kw
- 4 - Msq @ 2.0 kw
- 5 - Msq @ 3.0 kw
- 6 - Msq @ 4.0 kw

EMBEDDED TERMS:

JOB AIDS: A listing of the visual resolution capabilities of a number of simulators will be developed.

RULES: None

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 23 Jul 1987

SHORT TITLE: VISUAL GLOBAL CAT. NO: 3 LOCAL
CAT. NO: 3B2 EXTENDED TITLE: Visual Content
TITLE VARIATION 1: VIS CONTENT
TITLE VARIATION 2: VISUAL: CONT
TITLE VARIATION 3: Visual Content

VARIABLE NAME:

TITLE DEFINITION: The elements of the visual display produced by the image generation system which include terrain, cultural features, and three dimensional objects.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response capabilities, Visual Content

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert, Simulator Operator Manual, Engineering Specifications.

EXAMPLES:

MAIN PRODUCTS IMPACTED:

METRIC: Visual content is measured using a 6-point scale that places the elements of the visual display along a continuum.

- 1 - Plane with trees
- 2 - Plane with trees & generic terrain relief
- 3 - Plane with realistic
- 4 - Low density hydrographic & cultural features
- 5 - Medium " "
- 6 - High " "

EMBEDDED TERMS: None

JOB AIDS: Samples of the different types of scene content.

RULES: None

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 26 May 1987

SHORT TITLE: VISUAL TXTR GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3B3 EXTENDED TITLE: Visual Texture
TITLE VARIATION 1: VISUAL TXTR
TITLE VARIATION 2: vis texture
TITLE VARIATION 3: VISUAL TEXTURE

VARIABLE NAME:

TITLE DEFINITION: The "filler" generated by the computer system to enhance the realism of the scene content.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response Capabilities, Visual Texture

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert. Simulator Operator Manual. Engineering Specifications.

EXAMPLES:

MAIN PRODUCTS IMPACTED:

METRIC: visual texture is measure using a 5-point scale that places the types of textures along a continuum.

- 1 - Lines & Polygons
- 2 - Modulating functions
- 3 - Few digitized photographs
- 4 - More digitized photographs

EMBEDDED TERMS: None

JOB AIDS: Samples of the different types of texturing will be provided.

RULES: None

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 26 May 1987

SHORT TITLE: VISUAL:TXTR GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3B4 EXTENDED TITLE: Front Field-Of-View
TITLE VARIATION 1: FRONT FOV
TITLE VARIATION 2: Visual Front
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The front field-of-view refers to the area visible to the student pilot through the front display window.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response capabilities, Front Field of View (FDV)

INTEGRITY CONSTRAINTS: Numeric

SOURCES: training System Expert. Simulator Operator Manual. Engineering Specifications.

EXAMPLES:

MAIN PRODUCTS IMPACTED:

METRIC: Front field-of-view is measure using a 3-point scale that places field of view along a continuum.

- 1 - 40 degrees vertical by 40 degrees horizontal
- 2 - 40 degrees vertical by 50 degrees horizontal
- 3 - 40 degrees vertical by 60 degrees horizontal

EMBEDDED TERMS: None

JOB AIDS: Sample paragraphs from Simulator Operator Manuals describing Front Field-Of-View will be provided.

RULES: None

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 23 July 1987

SHORT TITLE: VISUAL:SIDE FDV GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3B5 EXTENDED TITLE: Side Field-Of-View
TITLE VARIATION 1: SIDE FDV
TITLE VARIATION 2: Visual Side
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The side field-of-view refers to the area visible to the student pilot through a side cockpit display window.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response Capabilities, Side Visual FDV

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert. Simulator Operator Manual. Engineering Specifications.

EXAMPLES:

MAIN PRODUCTS IMPACTED:

METRIC: Side Field-of-View is measured using a 7-point scale that places field-of-view along a continuum.

- 1 - 1 left window 40x40 deg
- 2 - 1 left window 40x50 deg
- 3 - 1 left window 40x60 deg
- 4 - left window 50x60 deg
- 5 - left & right window, 40x50 each
- 6 - left & right window, 40x60 each
- 7 - left & right window, 50x60 each

EMBEDDED TERMS: None

JOB AIDS: Sample paragraphs from simulator operator manuals describing Side Field-Of-View will be provided.

RULES: None

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 26 MAY 1987

SHORT TITLE: VISUAL:F/X PNTS GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3B6 EXTENDED TITLE: Scene Content: Point
Type Special Effects

TITLE VARIATION 1: SPL F/X PNTS
TITLE VARIATION 2: Point Effects
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The moving elements in the background scene content provided by the simulator's visual system.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response capabilities, Point Special Effects

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert. Simulator Operator Manual. Engineering Specifications.

EXAMPLES:

MAIN PRODUCTS IMPACTED:

METRIC: Point-type special effects are measured using a 6-point scale that places the effects along a continuum.

- 1 - None
- 2 - Cultural lights
- 3 - Cultural lights, weapons blast
- 4 - Cultural lights, weapons blast, damaged vehicles
- 5 - lights, blast, damaged vehicles and airborne & moving ground vehicles

EMBEDDED TERMS: NONE

JOB AIDS: Sample paragraphs from simulator operator manuals describing Point-type Special Effects will be provided.

RULES: NONE

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 26 MAY 1987

SHORT TITLE: VISUAL:F/X AREA GLOBAL CAT. NO: 3
LOCAL CAT.. NO: 3B7 EXTENDED TITLE: Scene Content: Area
Type Special Effects

TITLE VARIATION 1: SPL F/X AREA
TITLE VARIATION 2: AREA EFFECTS
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The special effects in the background scene content provided by the simulator's visual system.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response Capabilities, Area Special Effects

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert. Simulator Operator Manual. Engineering Specifications.

EXAMPLES:

MAIN PRODUCTS IMPACTED:

METRIC: Area-type Special Effects are measured using a 3-point scale that identifies the special effects available on the simulator.

- 1 - No special effects
- 2 - Smoke and dust
- 3 - Rotorwash effects

EMBEDDED TERMS: None

JOB AIDS: Sample paragraphs from simulator operator manuals describing Area-type Special Effects will be provided.

RULES: NONE

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 26 MAY 1987

SHORT TITLE: MOTION:PLTFM GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3B8 EXTENDED TITLE: Degrees of Platform Motion
TITLE VARIATION 1: MTN PLTFM
TITLE VARIATION 2: Platform Mot.
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The number of degrees of movement of the simulator platform about and along the horizontal, longitudinal, and vertical axes of the simulated aircraft.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response Capabilities, Platform Motion

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert. Simulator Operator Manual. Engineering Specifications.

EXAMPLES: Most of the major Army Flight Simulators have a six-degree-of-freedom motion system.

MAIN PRODUCTS IMPACTED:

METRIC: Platform motion ins measure using a 4-point scale that arranges the degrees of movement along a continuum.

- 1 - No motion
- 2 - 3 degrees of motion
- 3 - 5 degrees of motion

EMBEDDED TERMS: NONE

JOB AIDS: Sample paragraphs from simulator operator manuals describing platform degrees of motion will be provided.

RULES: NONE

NOTES: The motion system of modern flight simulators may also simulate ground effects (irregular surfaces), takeoff and landing (vibrations, impact), flight (turbulence, instability, vibrations,) abnormal flight (hydraulic failures, stability failures, rotor failures) and tactical (weapons firing, threat weapon hits, near misses).

ENTERED BY: Robert L. Reinwald ENTERED ON: 24 JULY 1987

SHORT TITLE: MOTION:SEAT GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3B9 EXTENDED TITLE: Extent Of Force-cuing Motion
TITLE VARIATION 1: MIN SEAT
TITLE VARIATION 2: Seat Motion
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The simulator force-cuing devices that operate separate from the platform motion system including seat shaker and o-seat.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response Capabilities, Seat Motion

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert. Simulator Operator Manual. Engineering Specifications.

EXAMPLES: The AH-1 Flight Simulator seat shaker simulates continuous and periodic oscillations and vibrations of normal flight and also vibrations of related to malfunctions. No examples of g-suit cuing device were found. The -10 Simulator Operator Manual describes.

MAIN PRODUCTS IMPACTED:

METRIC: Seat Motion is measured using a 3-point scale that places the types of seat motion along a continuum.

- 1 - Stationary
- 2 - Seat shaker
- 3 - Seat shaker and G-seat

EMBEDDED TERMS: None

JOB AIDS: Sample paragraphs from simulator operator manuals describing Seat Motion will be provided.

RULES: NONE

NOTES: The G-suit device was not included in the definition due to the lack of high g-forces generated by helicopter flight dynamics.

ENTERED BY: Robert L. Reinwald ENTERED ON: 24 JULY 1987

SHORT TITLE: SOUND F/X GLOBAL CAT. NO: 3
LOCAL. NO: 3B10 EXTENDED TITLE: Sound Effects
TITLE VARIATION 1: AUDIO F/X
TITLE VARIATION 2: Sound Special Effects
TITLE VARIATION 3: Sound Effects

VARIABLE NAME:

TITLE DEFINITION: The simulation of aircraft sound effects to enhance training.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response Capabilities, Sound Special Effects

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert. Simulator Operator Manual.

EXAMPLES: The AH-1 Flight Simulator sound simulation includes engine, compressor stall, main rotor, touchdown skid, transmission and gear train, hydraulics, grounded reflected and crash, auxiliary power unit, and weapons sounds of rockets, missiles, and gun.

MAIN PRODUCTS IMPACTED:

METRIC: TSE's indicated on a 4-point scale the range of sound effects provided by the simulator.

- 1 - None
- 2 - Weapons, skid, some failures
- 3 - Weapons, skid, some failures, normal operating noise
- 4 - Weapons, skids, failures, normal & abnormal engine noise

EMBEDDED TERMS: NONE

JCB AIDS: A checklist of possible sound effects will be provided.

RULES: NONE

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 22 JULY 1987

SHORT TITLE: MAP AREA GLOBAL CAT. NO: 4
LOCAL CAT. NO: 3B11 EXTENDED TITLE: Size of Map Area
TITLE VARIATION 1: Gaming Area
TITLE VARIATION 2: DATA SZ/CAL
TITLE VARIATION 3: Map Size

VARIABLE NAME:

TITLE DEFINITION: The size of the area within which the simulator's visual system is capable of operating.

POSITION DESCRIPTION: Training Device Data, Training Device Cue & Response Capabilities, Map Area

INTEGRITY CONSTRAINTS: NUMERIC

SOURCES: Training System Expert. Simulator Operator Manual. Engineering Specifications.

EXAMPLES: The UH-60 Flight Simulator and the AH-64 Combat Mission Simulator have a 32 kw by 40 kw map area of computer generated imagery of generic terrain and an airfield. The -10 Simulator Operator Manual is not consistent in Map Area description.

MAIN PRODUCTS IMPACTED:

METRIC: Map Area is measured using a 7-point scale that places the size of the area along a continuum.

- 1 - 5 x 5 km
- 2 - 10 x 10 km
- 3 - 10 x 20 km
- 4 - 10 x 30 km
- 5 - 20 x 30 km
- 6 - 30 x 30 km
- 7 - 30 x 40 km

EMBEDDED TERMS: NONE

JOB AIDS: Sample paragraphs from simulator operator manuals describing Map Area will be provided.

RULES: NONE

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 20 JULY 1987

SHORT TITLE: TUTORIAL GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3C1 EXTENDED TITLE: Tutorial
TITLE VARIATION 1: Tutorial
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Provides instruction to students and/or instructors on the features, capabilities, and appropriate uses of the simulator and its instructional support features.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, Tutorial

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator Operator Manual.

EXAMPLES: No Army aviation training devices were found with this feature. Navy Device 2E6, F-4/F-14 Air Combat Maneuvering Simulator uses a tutorial for the instructor's console operation.

MAIN PRODUCTS IMPACTED:

METRIC: The tutorial is a yes/no feature equal to 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS: A checklist of instruction features with examples should be developed.

RULES:

Informal: Complex Task Formal: Learning Rate <.7
Early Phase Entry Performance <.2

NOTES: This feature is rare in simulators, being state-of-the-art and software intensive. Surveys indicate instructors would utilize such a feature.

ENTERED BY: Robert L. Reinwald ENTERED ON: 15 JULY 1987

SHORT TITLE: SCENAR CNTL GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3C2 EXTENDED TITLE: Scenario Control
TITLE VARIATION 1: Scenario Control
TITLE VARIATION 2: scen cnt
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Provides instructor capability to configure and control the simulator so that simulated events occur according to a specific training scenario.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, Scenario Control

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator Operator Manual.

EXAMPLES: This feature is generally not used in aviation flight trainers. The UH-1 FS in the automated checkride mode has this feature and also the M1 Conduct of Fire Trainer (COFT). The -10 Simulator Operator Manual describes the feature.

MAIN PRODUCTS IMPACTED:

METRIC: Scenario control is a yes/no feature equal to 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS: A checklist of instruction features with examples will be developed.

RULES:

Informal: Tactical Tasks Formal: Same as Informal

ENTERED BY: Robert L. Reinwald ENTERED ON: 15 MAY 1987

SHORT TITLE: INIT COND GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3C3 EXTENDED TITLE: Initial Conditions
TITLE VARIATION 1: Init Conditions
TITLE VARIATION 2: int cond
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The capability to rapidly preset initial environmental and vehicle dynamic parameters from a set of previously selected values.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, Initial Conditions

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator operator Manual.

EXAMPLES: This is a common simulator feature found in most simulators. The -10 Simulator Operator Manual describes the initial conditions setup.

MAIN PRODUCTS IMPACTED:

METRIC: Initial conditions is a yes/no feature equal to 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS: A checklist of instructional features with examples will be developed.

RULES:

Informal: High Setup Time Formal: Setup Time > 5 minutes
Setup Time > 15%

NOTES: If the simulator has a Scenario Control feature, Initial Conditions may be incorporated into it.

ENTERED BY: Robert L. Reinwald ENTERED ON: 15 MAY 1987

SHORT TITLE: VARS CNTL GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3C4 EXTENDED TITLE: Real Time Variables
Control

TITLE VARIATION 1: Real-Time Control
TITLE VARIATION 2: Real-Time Variables Control
TITLE VARIATION 3: real time

VARIABLE NAME:

TITLE DEFINITION: Instructor capability to insert, remove, or otherwise alter simulator variables and parameters during a training exercise operation. Commonly known as real-time control.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, Real Time Variable Control

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator Operator Manual.

EXAMPLES: Most major simulators provided for changing from a few to most parameters and variables during training. The -10 Simulator Operator Manual describes this feature.

MAIN PRODUCTS IMPACTED:

METRIC: Variable control is a yes/no feature equal to a 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS: A checklist of instructional features with examples will be developed.

RULES:

Informal: Advanced Phase	Formal: Transfer Index > Std
Tactical Tasks	Same as Informal

NOTES: This feature would be utilized if the training requirement could not be adequately satisfied by the following features: Malfunction Control, Initial Conditions, and Scenario Control.

ENTERED BY: Robert L. Weinwald ENTERED ON: 15 JULY 1987

SHORT TITLE: MLFCN CNTL GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3C5 EXTENDED TITLE: Malfunction Control
TITLE VARIATION 1: Malfcn Control
TITLE VARIATION 2: Malfunction Insertion
TITLE VARIATION 3: mal cont

VARIABLE NAME:

TITLE DEFINITION: Capability to insert simulated malfunctions manually or automatically into a training exercise to train students in recognition and response to such malfunctions.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, Malfunction Insertion

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator Operator Manual.

EXAMPLES: Most major flight simulators provide over 200 malfunctions. The UH-60 Flight Simulator provides 344 malfunctions. The -10 Simulator Operator Manual lists and describes each malfunction, usually grouped by system function.

MAIN PRODUCTS IMPACTED:

METRIC: Malfunction control is a yes/no feature equal to 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS: A checklist of instructional features with examples will be developed.

RULES:

Informal: Task with Malfunction Informal: Same as Informal

NOTES: Automated malfunction insertion may require only instructor selection of the malfunction and setting activation parameters; the parameters may also already be preprogrammed. The Scenario Control feature may also include automated malfunction control.

ENTERED BY: Robert L. Weinwald ENTERED ON: 15 JULY 1987

SHORT TITLE: IOS DSPLY GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3C6 EXTENDED TITLE: Instructor/Operator
Station Display Control
TITLE VARIATION 1: IOS Display Cont
TITLE VARIATION 2: ios disp
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Provides the instructor with displays of current student performance during the training exercise via student station instrument replication and/or CRT displays of exercise status and control data.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, IOS Display

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator Operator Manual.

EXAMPLES: Current simulators use CRT displays depicting scenario status and management. The -10 Simulator Operator Manual provides descriptions and layout of the Instructor Operator Station (IOS).

MAIN PRODUCTS IMPACTED:

METRIC: IOS display is a yes/no feature equal to 1 or 0.

EMBEDDED TERM: NONE

JOB AIDS: A checklist of instructional features with examples will be developed.

RULES:

Informal: Continuous Control Formal: Same as Informal

NOTES: The IOS is often located apart from the student station platform. When the training requirement dictates Instructor Pilot/Operator direct observation of student performance, the IOS would be appropriately located.

ENTERED BY: Robert L. Weinwald ENTERED ON: 15 JULY 1987

SHORT TITLE: SYS FREEZ GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3C8 EXTENDED TITLE: System Freeze
TITLE VARIATION 1: System Freeze
TITLE VARIATION 2: sys frez
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Capability to freeze the entire training exercise for the purpose of training. May be initiated manually by the instructor or automatically by exceeding preselected parameters.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, System Freeze

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator Operator Manual.

EXAMPLES: Virtually every training device has a system freeze function. All training equipment utilizing hydraulic motion systems have instructor and student freeze capability for safety reasons. The -10 Simulator Operator Manual describes the feature.

MAIN PRODUCTS IMPACTED:

METRIC: System freeze is a yes/no feature equal to 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS: A checklist of instructional features with examples will be developed.

RULES:

Informal: Continuous Control	Formal: Same as Informal
Early Phase	Entry Performance <.4

NOTES:

ENTERED BY: Robert L. Weinwald ENTERED ON: 15 JULY 1987

SHORT TITLE: PARAM FREEZ GLOBAL CAT. NO: 3
LOCAT CAT. NO: 3C9 EXTENDED TITLE: Parameter Freeze
TITLE VARIATION 1: Parameter Freeze
TITLE VARIATION 2: parm frz
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Capability to freeze selected parameters of the training exercise for the purpose of training. May be initiated manually by the instructor or automatically by exceeding certain preselected parameters.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, Parameter Freeze

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator Operator Manual.

EXAMPLES: This is a common Feature for aviation flight trainers. Most use CRT display and keyboard to enable insertion of instructor selected frozen flight parameters. Aircraft parameters such as fuel quantity can also be selectable. The -10 Simulator Operator Manual describes.

MAIN PRODUCTS IMPACTED:

METRIC: Parameter freeze is a yes/no feature equal to 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS: A checklist of instructional features with examples will be developed.

RULES:

Informal: Continuous Control	Formal: Same as Informal
High Timesharing	Same as Informal
Complex Task	Learning Rate <.7

NOTES: This feature is most useful for initial training to reduce the difficulty of the training task being performed. May also be used to simulate cockpit instrument failure malfunctions.

ENTERED BY: Robert L. Weinwald ENTERED ON: 15 JULY 1987

SHORT TITLE: RECORD/RPLY GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3C10 EXTENDED TITLE: Record/Replay
TITLE VARIATION 1: Record/Playback
TITLE VARIATION 2: rec/play
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Simulator capability to record a student's actions and inputs during a training exercise. The simulator can dynamically replay the exercise or selected segments for the student's review.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, Record/Replay

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator Operator Manual.

EXAMPLES: A common feature of major flight simulators. The AH-1 Flight Simulator records and stores the last five minutes of elapsed training in one minute increments for instructor selection. Replay includes playback of synchronized current performance history with audio.

MAIN PRODUCTS IMPACTED:

METRIC: Record/replay is a yes/no feature equal to 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS: A checklist of instructional features with examples will be developed.

RULES:

Informal: Continuous Control	Formal: Same as Informal
High Timesharing	Same as Informal
Complex Task	Learning rate <.7
Early Phase	Earl Performance <.4

NOTES: Variable include length of playback, half-time playback, smaller increment playback selection, and flyout from Record/Playback to continue training at that point of the replay. This feature may be used to create and store demonstration scenarios.

ENTERED BY: Robert L. Weinwald ENTERED ON: 15 JULY 1987

SHORT TITLE: HARDCOPY GLOBAL CAT. NO: 3
LOCAT CAT. NO: 3C12 EXTENDED TITLE: Hardcopy/printout
TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Simulator capability to store/print data from any specified source within the simulation including CRT displays of graphic parameters and performance measurement for later debrief or record-keeping

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, Hard Copy

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator operator Manual.

EXAMPLES: A common feature. The AH-1 Flight Simulator (SF) will STORE PLOT 20 CRT page snapshots during an exercise. PRINT PLOT initiation during or after the exercise prints the stored data at the remote printer. The UH-60 FS stores up to 40 snapshots and ERROR PRINT SYSTEM data.

MAIN PRODUCTS IMPACTED:

METRIC: Hardcopy/Printout is a yes/no feature equal 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS: A checklist of instructional features with examples will be developed.

RULES:

Informal: All Formal: All

NOTES: This feature would also provide printouts of the Automated Performance Measurement feature is available. In order to limit the program screens requirements, Hardcopy was not included in the prototype OSBATS model. It will be included in the expanded version.

ENTERED BY: Robert L. Reinwald ENTERED: 16 JULY 1987

SHORT TITLE: REMOTE REPLAY COST: GLOBAL CAT. NO: 3
LOCAL CAT. NO: 3C13 EXTENDED TITLE: Remote Replay
TITLE VARIATION 1: Remote Graphics Replay
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DESCRIPTION: Capability to provide a graphic or symbolic replay of student performance for instructor post scenario debrief at a remote computer graphics console.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, Remote Replay

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training Systems Expert. Simulator Operator Manual.

EXAMPLES: The only Army aviation device with Remote Replay is the AH-64A Combat Mission Simulator. The display is located in each trainee cockpit and when activated, facilitates instructor and trainee communication of graphic or symbolic information or used for performance reviews and critiques.

MAIN PRODUCTS IMPACTED:

METRIC: Remote Replay is a yes/no feature equal to 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS:

Informal: All Formal: All

RULES:

NOTES: This feature is normally associated with team training. The remote display would be located apart from the training device and enable post-mission debrief to be conducted concurrent with normal training. If available, the Automated Performance Measurement feature would provide input. In order to limit the program screens requirements, Remote Replay was not included in the prototype OSBATS model. It will be in the expanded version.

ENTERED BY: Robert L. Weinwald ENTERED ON: 16 JULY 1987

SHORT TITLE: DATA ANAL GLOBAL CAT. NO: 3
LOCAT CAT. NO: 3C14 EXTENDED TITLE: Data Analysis
TITLE VARIATION 1: Data Storage
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Capability of the simulator to store, analyze, and retrieve archival data pertaining to objectives attainment for individual students, groups, or the simulator.

POSITION DESCRIPTION: Training Device Data, Training Device Instructional Features, Data Analysis

INTEGRITY CONSTRAINTS: Alphanumeric

SOURCES: Training System Expert. Simulator Operator Manual.

EXAMPLES: No aviation training equipment is known to have this feature. The Army M1 Conduct of Fire Trainer creates and maintains student training files including performance measurement and will provide trainer utilization data.

MAIN PRODUCTS IMPACTED:

METRIC: Data Analysis is a yes/no feature equal to 1 or 0.

EMBEDDED TERMS: NONE

JOB AIDS: A checklist of instructional features with examples will be developed.

RULES:

Informal: All Formal: All

NOTES: In order to limit the program screens requirements, Data Analysis was not included in the prototype OSBATS model. It will be included in the expanded version.

ENTERED BY: Robert L. Weinwald ENTERED ON: 16 JULY 1987

SHORT TITLE: FIDELITY:TECH PERF

GLOBAL CAT. NO: 4

LOCAL CAT. NO: 4A1 EXTENDED TITLE: Technical performance level
of fidelity for a feature

TITLE VARIATION 1:

TITLE VARIATION 2:

TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Technical Performance is the decimal value assigned to each level of the Cue & Response dimensions. It represents input used by the OSBATS model to run the Fidelity Optimization Module.

POSITION DESCRIPTION: Cue & Response Dimension data, Cue & Response Dimensions & Levels, Technical Performance

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Model User. Training System Expert. Subject Matter Expert.

EXAMPLES: Technical Performance (TP) for MOTION:PLTFM:

Level = 1 None, TP = 0

2 3 degrees of freedom, TP=.36

3 5 degrees of freedom, TP=.63

4 6 degrees of freedom, TP=.9

MAIN PRODUCTS IMPACTED:

METRIC: (refer to individual Cue & Response dimension data elements)

EMBEDDED TERMS: NONE

JOB AIDS: (refer to individual Cue & Response dimension data elements)

RULES: NONE

NOTES: The Prototype OSBATS model requires Cue & Response level conversion to the Technical Performance number. Future versions will require entry of only the Cue & Response level.

ENTERED BY: Robert L. Weinwald ENTERED ON: 10 AUGUST 1987

SHORT TITLE: FIDELITY:MIN COST GLOBAL CAT. NO: 4
LOCAL CAT. NO: 4B1 EXTENDED TITLE: Cost of a minimum level of
fidelity for a feature

TITLE VARIATION 1: MIN COST
TITLE VARIATION 2: Minimum Cost
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Minimum cost of a fidelity dimension
represents one parameter of the function used to estimate the
cost of a particular level of fidelity.

POSITION DESCRIPTION: Cue & Response Dimension Data, Cue &
Response Dimension Cost Data, Minimum Cost

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert

EXAMPLES: See Notes:

MAIN PRODUCTS IMPACTED:

METRIC:

EMBEDDED TERMS: NONE

JOB AIDS: See NOTES

RULES: NONE

NOTES: The prototype OSBATS Model Fidelity Optimization module
requires only the cost of the minimum and maximum levels of
fidelity for each of the eleven fidelity elements. Minimum and
maximum fidelity must be defined.

ENTERED BY: Robert L. Weinwald ENTERED ON: 28 JULY 1987

OSBATS DATA ELEMENT DICTIONARY

09-29-87

SHORT TITLE: FIDELITY:MAX COST GLOBAL CAT. NO: 4
LOCAL CAT. NO: 4B2 EXTENDED TITLE: Cost of a maximum level of
fidelity for a feature

TITLE VARIATION 1: MAX COST
TITLE VARIATION 2: Maximum Cost
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Maximum Cost of a fidelity dimension
represents one parameter of the function used to estimate the
cost of a particular level of fidelity.

POSITION DESCRIPTION: Cue & Response Dimension Data, Cue &
Response Dimension Cost Data, Maximum Cost

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert.

EXAMPLES: See NOTES

EMBEDDED TERMS: NONE

JOB AIDS: See NOTES

RULES: NONE

NOTES: The prototype OSBATS Model Fidelity Optimization module
requires only the cost of the minimum and maximum levels of
fidelity for each of the eleven fidelity elements. Minimum and
maximum fidelity must be defined.

ENTERED BY: Robert L. Reinwald

ENTERED ON: 28 JULY 1987

SHORT TITLE: FIDELITY:EXPONENT GLOBAL CAT. NO: 4
LOCAL CAT. NO: 4B3 EXTENDED TITLE: Exponent
TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The exponent associated with fidelity dimension costs describes the shape of the cost curve associated with a given fidelity dimension.

POSITION DESCRIPTION: Cue & Response Dimension Data, Cue & Response Dimension Cost Data, Exponent

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert. Model User.

EMBEDDED TERMS: NONE

JOB AIDS: N/A

RULES: NONE

NOTES: Historical cost data can be analyzed using regression analysis to derive an exponent which can be adjusted by the model user as required.

ENTERED BY: Robert L. Weinwald ENTERED ON: 10 AUGUST 1987

SHORT TITLE: MINIMUM PERFORMANCE PARAMETER GLOBAL CAT. NO: 4
LOCAL CAT. NO: 4C EXTENDED TITLE: Minimum performance
TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: Identifies fidelity dimensions for which fidelity is critical for transfer of training to occur based on training research.

POSITION DESCRIPTION: Cue & Response Dimension Data, Minimum Performance Parameter

INTEGRITY CONSTRAINTS:

SOURCES: Training Researcher. Training System Expert. Subject Matter Expert.

EXAMPLES: None. This element is internal to the OSBATS model.

EMBEDDED TERMS: NONE

JOB AIDS: N/A

RULES: NONE

NOTES:

ENTERED BY: Robert L. Reinwald ENTERED ON: 14 AUGUST 1987

SHORT TITLE: RULE CONDITIONS

GLOBAL CAT. NO: 5

LOCAL CAT. NO: 5A1 EXTENDED TITLE: Rule conditions for when to
use an instructional feature

TITLE VARIATION 1:

TITLE VARIATION 2:

TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The IF component of the training tasks IF-THEN rules that associate task characteristics to instructional features to determine appropriateness of the instructional feature to the task set.

POSITION DESCRIPTION: Instruction Feature Data, Instructional Feature Rules, Rule Conditions

INTEGRITY CONSTRAINTS: Not numeric

SOURCES: Training Researcher

EXAMPLES: Example of IF-THEN rule: IF Entry performance is <.4, and intrinsic feedback is absent, and the task involves continuous movement, or procedures, or decision making/rule using, THEN Automated Performance Alerts is indicated for this task. Rule Conditions is the IF component.

METRIC: N/A

EMBEDDED TERMS: NONE

JOB AIDS: NONE

RULES: N/A

NOTES: The THEN component of Instructional Features Rules is Implied Instructional Features. The instructional features rules are used to compute the benefit of each instructional feature on a task-by-task basis. The current OSBATS's rules are based on scientific research and are internal to the model. Future versions will make the rules available to the user.

ENTERED BY: Robert L. Reinwald

ENTERED ON: 13 AUGUST 1987

SHORT TITLE: IMPLIED INSTRUCTIONAL FEATURES GLOBAL CAT. NO: 5
LOCAL CAT. NO: 54A EXTENDED TITLE: Instructional features matched to task characteristics

TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME:

TITLE DEFINITION: The THEN component of the training tasks IF-THEN rules that associate task characteristics to instructional features to determine appropriateness of the instructional feature to the task set.

POSITION DESCRIPTION: Instructional Feature Data, Instructional Feature Rules, Implied Instructional features

INTEGRITY CONSTRAINTS: Not numeric

SOURCES: Training Researcher

EXAMPLES: Example of IF-THEN rule: IF entry performance is $<.4$ and intrinsic feedback is absent, and the task involved continuous movement, or procedures, or decision making/rule using, THEN Automated Performance Alerts is indicated. Implied Instructional Features is THEN component.

METRIC: N/A

EMBEDDED TERMS: NONE

JOB AIDS: N/A

RULES: N/A

NOTES: The IF component of Instructional Features Rules is Rule Conditions. The instructional features rules are used to compute the benefit of each instructional feature on a task-by-task basis. The current OSBATS's rules are based on scientific research and are internal to the model. Future versions will make the rules available to the user.

ENTERED BY: Robert L. Weinwald ENTERED ON: 13 AUGUST 1987

SHORT TITLE: INSTRUCTIONAL FEATURE:COST GLOBAL CAT. NO: 5
LOCAL CAT. NO: 5B1 EXTENDED TITLE: Acquisition cost of an
instructional feature

TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME: $\text{inf}(i).\text{cost}$

TITLE DEFINITION: The acquisition cost of an instructional
feature.

POSITION DESCRIPTION: Instructional Feature Data, Instructional
Feature Cost & Weight, Instructional Feature Cost

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training System Expert.

EXAMPLES: SEE NOTES

MAIN PRODUCTS IMPACTED:

METRIC: NONE

EMBEDDED TERMS: NONE

JOB AIDS: SEE NOTES

RULES: N/A

NOTES: The Prototype OSBATS Model Instructional Features module
requires an acquisition cost for each instructional feature to
compute cost/benefit/training efficiency relationships. The cost
for each feature will be approximated based on inputs from
training system experts.

ENTERED BY: Robert L. Weinwald

ENTERED ON: 28 JULY 1987

OSBATS DATA ELEMENT DICTIONARY

09-29-87

SHORT TITLE: INSTRUCTIONAL FEATURE:BENEFIT GLOBAL CAT. NO: 5
LOCAL CAT. NO: 5B2 EXTENDED TITLE: Instructional Feature
Benefit Weight

TITLE VARIATION 1:
TITLE VARIATION 2:
TITLE VARIATION 3:

VARIABLE NAME: inf(i).ben_wt

TITLE DEFINITION: Instructional Feature Benefit Weight reflects the frequency of need, instructor loading, and feature usability of the instructional feature.

POSITION DESCRIPTION: Instructional feature data, Instructional Feature Cost & Weight, IF Benefit Weight

INTEGRITY CONSTRAINTS: Numeric

SOURCES: Training Researcher. Subject Matter Expert.

EXAMPLES: This element is a measurement of the probability that the instructional feature will be used.

METRIC: N/A

EMBEDDED TERMS: NONE

JOB AIDS: N/A

RULES: NONE

NOTES: Advanced Instructional Features In Aircrew Training Devices: Utility and Utilization Patterns (1983) by Donald J. Polzella describes research into aircrew training device instructional feature usability and is the basis of instructional feature benefit weights for the current OSBATS model. This element would be updated as new research is made available or new instructional features were added.

ENTERED BY: Robert L. Reinwald ENTERED ON: 7 AUGUST 1987

09-29-87

VARIABLE NAME:

INTEGRITY CONSTRAINTS: Numeric

EXAMPLES: SEE NOTES

MAIN PRODUCTS IMPACTED:

METRIC: NONE

EMBEDDED TERMS: NONE

JOB AIDS: SEE NOTES

RULES: NONE

ENTERED BY: Robert L. Reinwald ENTERED ON: 28 JULY 1987

APPENDIX C
TRAINING DEVICE COST SURVEY

TRAINING DEVICE COST SURVEY

Device Nomenclature: _____

Weapon System Supported: _____

COST:INVEST	COST (in thousands)	YEAR INCURRED
a. Front-end analysis	_____	_____
b. Research & development	_____	_____
c. Acquisition/contracting	_____	_____
d. Device design, development, assembly, test and evaluation	_____	_____
e. ILS Support	_____	_____
f. Contractor Support (Oper & Maint)	_____	_____
g. Facilities/site preparation	_____	_____
h. Initial training	_____	_____
i. Curriculum development	_____	_____
j. Other	_____	_____
COST:INVEST = (sum of a through j) = _____		

COST: FIXED/YEAR	COST (in thousands)
a. Service contract costs	_____
b. Internal support costs	_____
c. Supplies/materials for scheduled maintenance	_____
d. Facilities costs	_____
e. Other	_____
COST: FIXED/YR = (sum of a through e) = _____	

TRAINING DEVICE COST SURVEY

COST: VARIABLE/HOURLY

COST
(in thousands)

- a. Instructor salaries _____
- b. Instructional supplies _____
- c. Unscheduled maintenance _____
- d. Student salaries _____
- e. Extra hours of service added to basic
fixed service contract _____
- f. Other _____

COST: VAR/HR = (sum of a through g) = _____

LIFE-CYCLE

- a. Industry standard life cycle _____
- b. Estimated life cycle of the actual
equipment supported by the training device _____

LIFE-CYCLE = [(a plus b) divided by 2] = _____

UTILIZATION HOURS / YEAR

- a. Hours per year the simulator in use
(by direction) _____
- b. Hours per year the simulator is down for
repair other than maintenance _____

UTIL(HR/YR) = (a minus b) = _____

TRAINING DEVICE COST SURVEY

INSTRUCTIONAL FEATURE: COST	Software Development Costs (in thousands)
TUTORIAL	_____
SCENARIO CONTROL	_____
INITIATING CONDITIONS	_____
VARIABLE CONTROL	_____
MALFUNCTION CONTROL	_____
INSTRUCTOR / OPERATOR CONTROL	_____
PROCEDURES MONITORING	_____
SYSTEM FREEZE	_____
PARAMETER FREEZE	_____
RECORD / REPLAY	_____
PERFORMANCE MEASUREMENT	_____
HARDCOPY	_____
REMOTE REPLAY	_____
DATA ANALYSIS	_____
ADAPTIVE FUNCTIONS	_____
AUGMENTING CUES	_____
AUGMENTING FEEDBACK	_____
AUTOMATIC DEMONSTRATION	_____
AUTOMATIC COACHING	_____
CRASH OVERPIDE	_____
SITUATION FREEZE	_____
GRAPHIC REPLAY	_____
PERFORMANCE INDICATORS	_____
PERFORMANCE ALERT	_____
REALTIME MONITORING	_____
RESET / RESTART	_____

TRAINING DEVICE COST SURVEY

FIDELITY: COST AND DESCRIPTION

	Software	Hardware	Total (\$K)
VISUAL:RES DESCRIPTION:	_____	_____	_____
VISUAL:CONT DESCRIPTION:	_____	_____	_____
VISUAL:TXTR DESCRIPTION:	_____	_____	_____
VISUAL:FRONT FOV DESCRIPTION:	_____	_____	_____
VISUAL:SIDE FOV DESCRIPTION:	_____	_____	_____
VISUAL:F/X PNTS DESCRIPTION:	_____	_____	_____
VISUAL:F/X AREA DESCRIPTION:	_____	_____	_____
MOTION:PLTFM DESCRIPTION:	_____	_____	_____
MOTION:SEAT DESCRIPTION:	_____	_____	_____
SOUND F/X DESCRIPTION:	_____	_____	_____
MAP AREA DESCRIPTION:	_____	_____	_____

APPENDIX D
UH-1 TRAINING DEVICE TASK SURVEY

UH-1 COCKPIT PROCEDURES TRAINER (CPT) SURVEY

Introduction

The Army Research Institute is gathering data on the effectiveness of existing training devices. The purpose of this survey is to obtain information from subject matter experts on the training effectiveness of the UH-1 CPT (2C35).

The survey has been designed to obtain information about (a) the instructional features available on the UH-1 Cockpit Procedures Trainer, and (b) how much the UH-1 CPT sounds, looks, acts, and operates like the UH-1 when training specific tasks. The survey covers the following subject areas:

- personal data,
- overall effectiveness of instructional features,
- effectiveness of instructional features for specific tasks,
- fidelity adequacy of sound features,
- fidelity adequacy of displays and controls, and
- fidelity adequacy of display and control interactions.

You have been selected to complete this survey because of your expertise as an instructor in the UH-1 Cockpit Procedures Trainer. Careful attention to the instructions and completion of all items is requested. The data from this survey will be used to aid training system designers in the future.

SECTION A: PERSONAL DATA SHEET

1. Enter your name and grade. (Note: This information will be used only in the event that it is necessary to contact you for further information.)

Name _____

Grade _____

2. Indicate below your present duty position(s)

_____ Instructor Pilot

_____ Simulator Instructor

_____ Simulator Operator

3. Check (✓) the helicopter(s) in which you are qualified and current or have been qualified (check as many as apply). In the space provided, write the number of hours you have logged in each helicopter.

	Qualified And Current	Qualified But Not Current	Hours Logged
UH-1	[]	[]	_____
UH-60	[]	[]	_____
OH-58	[]	[]	_____
OH-23	[]	[]	_____
OH-13	[]	[]	_____
OH-6	[]	[]	_____
CH-54	[]	[]	_____
CH-47	[]	[]	_____
AH-64	[]	[]	_____
AH-1	[]	[]	_____
TH-55	[]	[]	_____

4. Check (✓) the training device(s) in which you are qualified and current as an instructor or have been qualified (check as many as apply).

	Qualified And Current	Qualified But Not Current
UH1FS	[]	[]
CH47FS	[]	[]
UH60FS	[]	[]
AH1FWS	[]	[]
AH-64 CMS	[]	[]
UH-1 CPT	[]	[]
AH-1 APT	[]	[]
AH-64 TSTT	[]	[]
AH-64 CWEPT	[]	[]
OH-58 CST	[]	[]
Other(s) (specify)		
_____	[]	[]
_____	[]	[]
_____	[]	[]

5. Indicate below the hours of training you have received on the instructional features of the training devices listed.

	Classroom Training	Device Hands-on Training
UH1FS	[]	[]
CH47FS	[]	[]
UH60FS	[]	[]
AH1FWS	[]	[]
AH-64 CMS	[]	[]
UH-1 CPT	[]	[]
AH-1 APT	[]	[]
AH-64 TSTT	[]	[]
AH-64 CWEPT	[]	[]
OH-58 CST	[]	[]

6. Indicate below the number of hours you have logged as pilot/copilot in the training devices listed below.

UH1FS	_____	hours
CH47FS	_____	hours
UH60FS	_____	hours
AH1FWS	_____	hours
AH-64 CMS	_____	hours
UH-1 CPT	_____	hours
AH-1 APT	_____	hours
AH-64 TSTT	_____	hours
AH-64 CWEPT	_____	hours
OH-58 CST	_____	hours

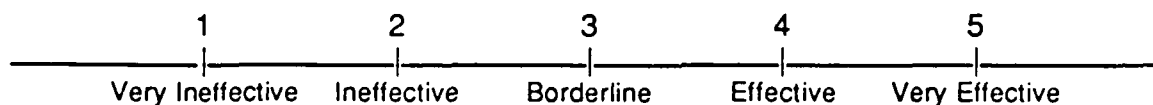
7. Indicate below the number of months you spent as an instructor on each of the following training devices.

UH1FS	_____	months
CH47FS	_____	months
UH60FS	_____	months
AH1FWS	_____	months
AH-64 CMS	_____	months
UH-1 CPT	_____	months
AH-1 APT	_____	months
AH-64 TSTT	_____	months
AH-64 CWEPT	_____	months
OH-58 CST	_____	months
Other(s) (specify)		
_____	_____	months
_____	_____	months
_____	_____	months

SECTION B: OVERALL EFFECTIVENESS OF INSTRUCTIONAL FEATURES

Instructions

The items listed below are designed to obtain information about the overall **effectiveness** of the instructional features on the UH-1 CPT. Read the definition of each instructional feature. In the space provided, place your rating of how effective the instructional feature is in providing training during UH-1 CPT lessons. Use the scale provided to make your ratings.



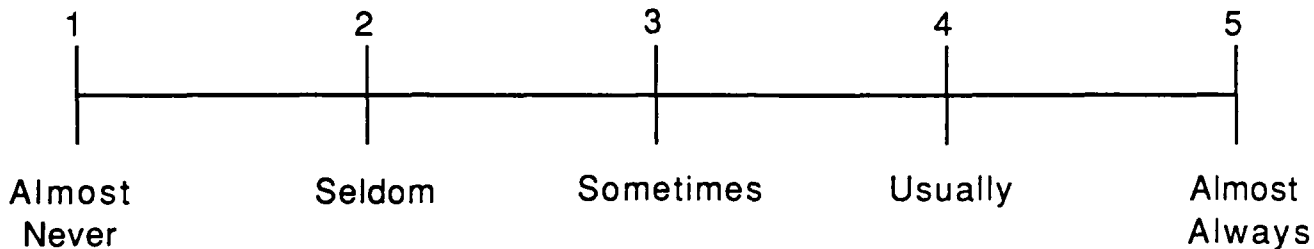
INSTRUCTIONAL FEATURE DEFINITIONS

- **Data Analysis** - capability of the device to store, retrieve, and analyze information pertaining to attainment of instructional objectives.
Overall Rating_____
- **Malfunction Insertion** - capability to insert simulated malfunctions manually or automatically into a training exercise.
Overall Rating_____
- **Performance Measure** - capability to calculate quantitative measures of student performance for use in assessing student progress and/or diagnosing student performance problems.
Overall Rating_____

OVERALL USAGE OF INSTRUCTIONAL FEATURES

Instructions

The items below are designed to obtain information about the overall usage of the instructional features on the UH-1 CPT. Read the definition of each instructional feature. In the space provided, place your rating of how often you have used the instructional feature during UH-1 CPT lessons. Use the scale provided to make your ratings.



INSTRUCTIONAL FEATURE DEFINITIONS

• **Data Analysis** - capability of the device to store, retrieve, and analyze information pertaining to objective attainment.

Overall Rating _____

• **Malfunction Insertion** - capability to insert simulated malfunctions manually or automatically into a training exercise.

Overall Rating _____

• **Performance Measurement** - capability to calculate quantitative measures of student performance for use in assessing student progress and/or diagnose student performance problems.

Overall Rating _____

SECTION C: EFFECTIVENESS OF INSTRUCTIONAL FEATURES FOR SPECIFIC TASKS

Instructions

Listed on the following pages are the tasks taught in the UH-1 CPT. Using the scale provided below, rate the **effectiveness** of each instructional feature in **training the task**. Record your rating in the row for the task under the column representing the specific instructional feature. If the feature is not used for training a task, enter N/A. If you feel there is some other instructional feature that would be effective in training a specific task, please provide that information in the space provided at the end of the list of tasks.

SCALE FOR RATING THE EFFECTIVENESS OF INSTRUCTIONAL FEATURES FOR SPECIFIC TASKS

1	2	3	4	5	6	7
Unacceptable	Poor	Fair	Average	Good	Outstanding	Superior

UH-1 COCKPIT AND EMERGENCY PROCEDURES

TASK	INSTRUCTIONAL FEATURE		
	DATA ANALYSIS	MALFUNCTION INSERTION	PERFORMANCE MEASURE
Correct Procedures for Low Battery			
Correct Procedures for Hot Start			
Emergency Procedures (EP) for Main Generator Malfunction			
EP for Overheated Battery			
EP for Hydraulic Power Failure			
EP for Single Fuel Boost Pump Failure			
EP for Dual Fuel Boost Pump Malfunction			
EP for Engine Fuel Pump Malfunction			
EP for Fuel Filter Contamination			
EP for Engine Chip Detector			
EP for Transmission/Tail Rotor Chip Detector			
EP for Fire in Flight			
EP for Inlet Guide Vane Actuator Failure			
EP for Compressor Stall			
EP for Main Drive Shaft/Clutch Failure			
EP for Clutch Fails to Disengage			
EP for Engine Malfunction Low Altitude/ Low Airspeed or Cruise			
EP for Engine Overspeed			
EP for Transmission Oil Pressure Low			
EP for Transmission Oil Temperature High			
EP for Engine Oil High or Low Pressure			
EP for Engine Oil Temperature High			
EP for Spare Caution Light Illumination			
EP for Master Caution Light Illumination			
EP for Electrical Fire in Flight			

In the space below, please provide information if you feel there is some other instructional feature that would be effective in training a specific task. For each comment, list the specific task followed by the suggested instructional feature.

Specific Task

Instructional Feature

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

SECTION D: FIDELITY ADEQUACY OF SOUND FEATURES

Instructions

In this section of the survey, you are asked to rate the fidelity adequacy of the **normal** and **abnormal sound effects** for the tasks taught in the UH-1 CPT. Normal sound effects are the sounds for normal operations. Abnormal sound effects are the sounds that accompany malfunctions. Please use the following scale for your fidelity adequacy rating. Rate both normal and abnormal sound effects for each task listed.

- A - Fidelity is adequate
- L - Less fidelity could be used
- M - More fidelity is required
- N/A - Not appropriate for this task

Record an "A" in the space provided to indicate that the fidelity of the sound effects is considered adequate for training the task, an "L" to indicate that less fidelity of the sound effects could be used, or an "M" to indicate that more fidelity of the sound effects is required. If sound effects are not used to train students in the task, enter N/A. If you feel sound could be incorporated into the trainer to increase training effectiveness for a task, please provide the information in the Comments section.

UH-1 COCKPIT AND EMERGENCY PROCEDURES

TASK	SOUND EFFECTS	
	NORMAL	ABNORMAL
Correct Procedures for Low Battery		
Correct Procedures for Hot Start		
Emergency Procedures (EP) for Main Generator Malfunction		
EP for Overheated Battery		
EP for Hydraulic Power Failure		
EP for Single Fuel Boost Pump Failure		
EP for Dual Fuel Boost Pump Malfunction		
EP for Engine Fuel Pump Malfunction		
EP for Fuel Filter Contamination		
EP for Engine Chip Detector		
EP for Transmission/Tail Rotor Chip Detector		
EP for Fire in Flight		
EP for Inlet Guide Vane Actuator Failure		
EP for Compressor Stall		
EP for Main Drive Shaft/Clutch Failure		
EP for Clutch Fails to Disengage		
EP for Engine Malfunction Low Altitude/ Low Airspeed or Cruise		
EP for Engine Overspeed		
EP for Transmission Oil Pressure Low		
EP for Transmission Oil Temperature High		
EP for Engine Oil High or Low Pressure		
EP for Engine Oil Temperature High		
EP for Spare Caution Light Illumination		
EP for Master Caution Light Illumination		
EP for Electrical Fire in Flight		

Comments:

SECTION E: FIDELITY ADEQUACY OF DISPLAYS AND CONTROLS

Instructions

In this section of the survey, you are asked to rate the fidelity adequacy of the **displays** and **controls** for the tasks taught in the UH-1 CPT. Fidelity refers to how well the UH-1 CPT displays and controls look like the UH-1's. Please use the following scale for your fidelity adequacy ratings. Rate each display and control for each task listed.

- A - Fidelity is adequate
- L - Less fidelity could be used
- M - More fidelity is required
- N/A - Not appropriate for this task

Record an "A" in the space provided to indicate that the display or control fidelity is considered adequate for training the task, an "L" to indicate that less fidelity could be used, or an "M" to indicate that more fidelity is required. If a display or control is not used, enter N/A. A separate page for displays and for controls is provided for your ratings.

UH-1 COCKPIT AND EMERGENCY PROCEDURES

TASK	DISPLAYS			
	ELECTRICAL	FUEL	ENGINE	FLIGHT
Correct Procedures for Low Battery				
Correct Procedures for Hot Start				
Emergency Procedures (EP) for Main Generator Malfunction				
EP for Overheated Battery				
EP for Hydraulic Power Failure				
EP for Single Fuel Boost Pump Failure				
EP for Dual Fuel Boost Pump Malfunction				
EP for Engine Fuel Pump Malfunction				
EP for Fuel Filter Contamination				
EP for Engine Chip Detector				
EP for Transmission/Tail Rotor Chip Detector				
EP for Fire in Flight				
EP for Inlet Guide Vane Actuator Failure				
EP for Compressor Stall				
EP for Main Drive Shaft/Clutch Failure				
EP for Clutch Failure to Disengage				
EP for Engine Malfunction Low Altitude/ Low Airspeed or Cruise				
EP for Engine Overspeed				
EP for Transmission Oil Pressure Low				
EP for Transmission Oil Temperature High				
EP for Engine Oil High or Low Pressure				
EP for Engine Oil Temperature High				
EP for Spare Caution Light Illumination				
EP for Master Caution Light Illumination				
EP for Electrical Fire in Flight				

Comments:

UH-1 COCKPIT AND EMERGENCY PROCEDURES

TASK	CONTROLS			
	ELECTRICAL	FUEL	ENGINE	FLIGHT
Correct Procedures for Low Battery				
Correct Procedures for Hot Start				
Emergency Procedures (EP) for Main Generator Malfunction				
EP for Overheated Battery				
EP for Hydraulic Power Failure				
EP for Single Fuel Boost Pump Failure				
EP for Dual Fuel Boost Pump Malfunction				
EP for Engine Fuel Pump Malfunction				
EP for Fuel Filter Contamination				
EP for Engine Chip Detector				
EP for Transmission/Tail Rotor Chip Detector				
EP for Fire in Flight				
EP for Inlet Guide Vane Actuator Failure				
EP for Compressor Stall				
EP for Main Drive Shaft/Clutch Failure				
EP for Clutch Fails to Disengage				
EP for Engine Malfunction Low Altitude/ Low Airspeed or Cruise				
EP for Engine Overspeed				
EP for Transmission Oil Pressure Low				
EP for Transmission Oil Temperature High				
EP for Engine Oil High or Low Pressure				
EP for Engine Oil Temperature High				
EP for Spare Caution Light Illumination				
EP for Master Caution Light Illumination				
EP for Electrical Fire in Flight				

Comments:

SECTION F: FIDELITY ADEQUACY OF DISPLAY AND CONTROL INTERACTIONS

Instructions

In this section of the survey, you are asked to rate the fidelity adequacy of the **interactions** between the displays and controls for tasks taught in the UH-1 CPT. Here fidelity refers to how well the UH-1 CPT displays and controls act and operate like the UH-1's. For each task listed please use the following scale to indicate your fidelity adequacy ratings of the interactions between the displays and controls for each subsystem.

- A - Fidelity is adequate
- L - Less fidelity could be used
- M - More fidelity is required
- N/A - Not appropriate for this task

Record an "A" in the space provided to indicate that the fidelity of the interactions of displays and controls is considered adequate for training the task, an "L" to indicate that less interaction fidelity could be used, or an "M" to indicate that more interaction fidelity is required. Enter N/A if there is no interaction between displays and controls.

UH-1 COCKPIT AND EMERGENCY PROCEDURES

TASK	SUBSYSTEMS			
	ELECTRICAL	FUEL	ENGINE	FLIGHT
Correct Procedures for Low Battery				
Correct Procedures for Hot Start				
Emergency Procedures (EP) for Main Generator Malfunction				
EP for Overheated Battery				
EP for Hydraulic Power Failure				
EP for Single Fuel Boost Pump Failure				
EP for Dual Fuel Boost Pump Malfunction				
EP for Engine Fuel Pump Malfunction				
EP for Fuel Filter Contamination				
EP for Engine Chip Detector				
EP for Transmission/Tail Rotor Chip Detector				
EP for Fire in Flight				
EP for Inlet Guide Vane Actuator Failure				
EP for Compressor Stall				
EP for Main Drive Shaft/Clutch Failure				
EP for Clutch Fails to Disengage				
EP for Engine Malfunction Low Altitude/ Low Airspeed or Cruise				
EP for Engine Overspeed				
EP for Transmission Oil Pressure Low				
EP for Transmission Oil Temperature High				
EP for Engine Oil High or Low Pressure				
EP for Engine Oil Temperature High				
EP for Spare Caution Light Illumination				
EP for Master Caution Light Illumination				
EP for Electrical Fire in Flight				

Comments:

APPENDIX E
AH-64 TRAINING DEVICE TASK SURVEY

AH-64 COCKPIT, WEAPONS AND EMERGENCY PROCEDURES TRAINER (CWEPT) SURVEY (FRONT SEAT)

Introduction

The Army Research Institute is gathering data on the effectiveness of existing training devices. The purpose of this survey is to obtain information from subject matter experts on the effectiveness of training front seat operations in the AH-64 CWEPT.

The survey has been designed to obtain information about (a) the instructional features available on the CWEPT, and (b) how much the CWEPT sounds, looks, acts, and operates like the AH-64 when training specific tasks. The survey covers the following subject areas:

- personal data,
- overall effectiveness of instructional features,
- effectiveness of instructional features for specific tasks,
- fidelity adequacy of specific design features,
- utility of visual scene content and special effects,
- fidelity adequacy of displays and controls, and
- fidelity adequacy of display and control interactions.

You have been selected to complete this survey because of your expertise as a CWEPT instructor. Careful attention to the instructions and completion of all items is requested. The data from this survey will be used to aid training system designers in the future.

4. Check (✓) the training device(s) in which you are qualified and current as an instructor or have been qualified (check as many as apply).

	Qualified And Current	Qualified But Not Current
UH1FS	[]	[]
CH47FS	[]	[]
UH60FS	[]	[]
AH1FWS	[]	[]
AH-64 CMS	[]	[]
UH-1 CPT	[]	[]
AH-1 APT	[]	[]
AH-64 TSTT	[]	[]
AH-64 CWEPT	[]	[]
OH-58 CST	[]	[]
Other(s) (specify)		
_____	[]	[]
_____	[]	[]
_____	[]	[]

5. Indicate below the hours of training you have received on the instructional features of the training devices listed.

	Classroom Training	Device Hands-on Training
UH1FS	_____	_____
CH47FS	_____	_____
UH60FS	_____	_____
AH1FWS	_____	_____
AH-64 CMS	_____	_____
UH-1 CPT	_____	_____
AH-1 APT	_____	_____
AH-64 TSTT	_____	_____
AH-64 CWEPT	_____	_____
OH-58 CST	_____	_____

6. Indicate below the number of hours you have logged as pilot/copilot in the training devices listed below.

UH1FS	_____	hours
CH47FS	_____	hours
UH60FS	_____	hours
AH1FWS	_____	hours
AH-64 CMS	_____	hours
UH-1 CPT	_____	hours
AH-1 APT	_____	hours
AH-64 TSTT	_____	hours
AH-64 CWEPT	_____	hours
OH-58 CST	_____	hours

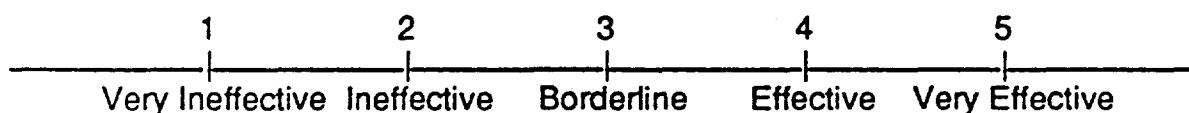
7. Indicate below the number of months you spent as an instructor on each of the following training devices.

UH1FS	_____	months
CH47FS	_____	months
UH60FS	_____	months
AH1FWS	_____	months
AH-64 CMS	_____	months
UH-1 CPT	_____	months
AH-1 APT	_____	months
AH-64 TSTT	_____	months
AH-64 CWEPT	_____	months
OH-58 CST	_____	months
Other(s) (specify)		
_____	_____	months
_____	_____	months
_____	_____	months

SECTION B: OVERALL EFFECTIVENESS OF INSTRUCTIONAL FEATURES

Instructions

The items listed below are designed to obtain information about the overall **effectiveness** of the instructional features on the AH-64 CWEPT. Read the definition of each instructional feature. In the space provided, place your rating of how effective the instructional feature is in providing training during CWEPT lessons. Use the scale provided to make your ratings.



INSTRUCTIONAL FEATURE DEFINITIONS

- **Hardcopy** - capability to "print out" selected displays and/or preprogrammed reports for briefing/debriefing and record keeping.
Overall Rating_____
- **Initial Conditions** - capability to preset the trainer to specific environmental conditions and to specific dynamic parameters.
Overall Rating_____
- **IOS Display** - provides the instructor with displays of current student performance during the training exercise. Overall Rating_____
- **Malfunction Insertion** - capability to insert simulated malfunctions manually or automatically into a training exercise.
Overall Rating_____
- **Parameter Freeze** - capability to freeze selected parameters during the training exercise.
Overall Rating_____
- **Performance Measure** - capability to calculate quantitative measures of student performance for use in assessing student progress and/or diagnosing student performance problems.
Overall Rating_____
- **Procedures Monitoring** - capability to monitor and document student performance of specific normal and emergency procedures from a display instead of direct observation.
Overall Rating_____

- **Scenario Control** - capability to configure the simulator/device so that events are controlled according to a specific scenario.

Overall Rating_____

- **System Freeze** - capability to temporarily halt the entire training exercise.

Overall Rating_____

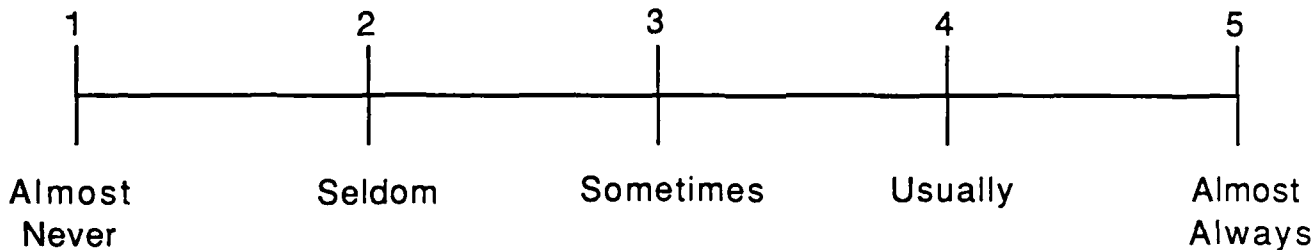
- **Variable Control** - capability to insert, remove, or change the simulator/device parameters during a training exercise.

Overall Rating_____

OVERALL USAGE OF INSTRUCTIONAL FEATURES

Instructions

The items below are designed to obtain information about the overall usage of the instructional features on the AH-64 CWEPT. Read the definition of each instructional feature. In the space provided, place your rating of how often you have used the instructional feature during UH-1 CPT lessons. Use the scale provided to make your ratings.



INSTRUCTIONAL FEATURE DEFINITIONS

- **Hardcopy** - capability to "print out" selected displays and/or preprogrammed reports for briefing/debriefing and record keeping.

Overall Rating _____

- **Initial Conditions** - capability to preset the trainer to a specific environmental condition and preset the dynamic parameters.

Overall Rating _____

- **IOS Display** - provides the instructor with displays of current student performance during the training exercise.

Overall Rating _____

- **Malfunction Insertion** - capability to insert simulated malfunctions manually or automatically into a training exercise.

Overall Rating _____

- **Parameter Freeze** - capability to freeze selected parameters during the training exercise.

Overall Rating _____

- **Performance Measurement** - capability to calculate quantitative measures of student performance for use in assessing student progress and/or diagnose student performance problems.

Overall Rating _____

- **Procedures Monitoring** - capability to monitor and document student performance of specific normal and emergency procedures from a display instead of direct observation.

Overall Rating _____

- **Scenario Control** - capability to configure the simulator/device so that events are controlled according to a specific scenario.

Overall Rating _____

- **System Freeze** - capability to temporarily halt the entire training exercise.

Overall Rating _____

- **Variable Control** - capability to insert, remove, or change the simulator/device parameters during a training exercise.

Overall Rating _____

SECTION C: EFFECTIVENESS OF INSTRUCTIONAL FEATURES FOR SPECIFIC TASKS

Instructions

Listed on the following pages are the tasks taught in the AH-64 CWEPT. Using the scale provided below, rate the **effectiveness** of each instructional feature in **training the task**. Record your rating in the row for the task under the column representing the specific instructional feature. If the feature is not used for training a task, enter N/A. If you feel there is some other instructional feature that would be effective in training a specific task, please provide that information in the space provided at the end of the list of tasks.

SCALE FOR RATING THE EFFECTIVENESS OF INSTRUCTIONAL FEATURES FOR SPECIFIC TASKS

1	2	3	4	5	6	7
_____	_____	_____	_____	_____	_____	_____
Unacceptable	Poor	Fair	Average	Good	Outstanding	Superior

AM-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (FRONT SEAT)

TASK	HARDCOPY	INITIAL CONDITIONS	IOS DISPLAY	MALFUNCTION INSERTION	PARAMETER FREEZE
Interior Check					
Before-Starting Auxiliary Power Unit (APU) Procedures					
After Starting APU					
Preflight Data Entry Procedures					
IHADSS Boresight Procedures					
Doppler Program Procedures					
TADS Internal Boresight					
TADS Out-Front Boresight					
Extension, Employment, and Stowing of Cyclic					
Weapons Arming Procedures					
Select Appropriate Weapon System					
Direct View Optics (DVO) Operations					
Day Television (DTV) Operations					
Forward-Looking Infrared (FLIR) Operations					
Laser Spot Tracker Operations					
Image Auto Tracker Operations					
Laser Rangefinder/Designator Operations					
Target Store Procedures					
Emergency Procedure for Symbol Generator Failure					
Aircraft Position Update Function Procedures					
Target Tracking Using IHADSS					
IHADSS Operations					
Search For and Identify Targets With TADS					
Search, Acquire, Recognize, and Identify Targets With DTV					
Search, Acquire, Recognize, and Identify Targets With FLIR					
Search, Acquire, Recognize, and Identify Targets With DVO					
Target Tracking (TADS)					
Target Handover					
Operate Area Weapons System					
Engage Target With 30-mm Gun					
Operate Aerial Rocket Control System					
Engage Target With 270-Inch FFAR Homing Mode Only					
Engage Target With 270-Inch FFAR Non-Homing Mode Only					
Identify Target With Laser Method					
Identify Target With Thermal Method					
OBL Read Fire Procedures					
OBL Read Fire Procedures Lock On After Launch (LOAL) Procedures					
CAL Read Fire Procedures					
CAL Read Fire Procedures					

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (FRONT SEAT) [CONTINUED]

TASK	PERFORMANCE MEASUREMENT	PROCEDURES MONITORING	SCENARIO CONTROL	SYSTEM FREEZE	VARIABLE CONTROL
Interior Check					
Before Starting Auxiliary Power Unit (APU) Procedures					
After Starting APU					
Preflight Data Entry Procedures					
IHADSS Boresight Procedures					
Doppler Program Procedures					
TADS Internal Boresight					
TADS Out-Front Boresight					
Extension, Employment, and Stowing of Cyclic					
Weapons Arming Procedures					
Select Appropriate Weapon System					
Direct View Optics (DVO) Operations					
Day Television (DTV) Operations					
Forward-Looking Infrared (FLIR) Operations					
Laser Spot Tracker Operations					
Image Auto Tracker Operations					
Laser Rangefinder/Designator Operations					
Target Store Procedures					
Emergency Procedure for Symbol Generator Failure					
Aircraft Position Update Function Procedures					
Target Tracking Using IHADSS					
IHADSS Operations					
Search For and Identify Targets With TADS					
Search, Acquire, Recognize, and identify Targets With DTV					
Search, Acquire, Recognize, and identify Targets With FLIR					
Search, Acquire, Recognize, and identify Targets With DVO					
Target Tracking (TADS)					
Target Handover					
Operate Area Weapons System					
Engage Target With 30-mm Gun					
Operate Aerial Rocket Control System					
Launch Air-to-Air Missiles From Cockpit or Radar					
Identify Threats					
Joint Target-Weapon System Allocation					
Allocate Targets To Available Weapons					
Reallocate Targets To Other Weapons As Needed					
OBL Ready Fire Procedures					
OBL Ready Fire Procedures					
Lock On After Launch (LOAL) Procedures					
CAL Ready Fire Procedures					
OAI Ready Fire Procedures					

In the space below, please provide information if you feel there is some other instructional feature that would be effective in training a specific task. For each comment, list the specific task followed by the suggested instructional feature.

Specific Task

Instructional Feature

SECTION D: FIDELITY ADEQUACY OF SPECIFIC DESIGN FEATURES

Instructions

In this section of the survey, you are asked to rate the fidelity adequacy of the training device's **design features** for the tasks taught in the AH-64 CWEPT. Fidelity refers to how well the CWEPT sounds, looks, feels, acts, and operates like the AH-64. Please use the following scale to indicate your fidelity adequacy ratings. Rate each design feature for each task listed.

- A - Fidelity is adequate
- L - Less fidelity could be used
- M - More fidelity is required
- N/A - Not appropriate for this task

Record an "A" in the space provided to indicate that the design feature's fidelity is considered adequate for training the task, an "L" to indicate that less fidelity could be used, or an "M" to indicate that more fidelity is required. If the design feature is not used for training the task, enter N/A.

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (FRONT SEAT)

TASK	SOUND EFFECTS	DESIGN FEATURE						SIZE OF GAMING AREA
		VISUAL IMAGE OF HEADS DOWN			VISUAL IMAGE OF HEADS OUT			
		FLIR	DVO	DTV	FLIR	DVO	DTV	
Interior Check								
Before-Starting Auxiliary Power Unit (APU) Procedures								
After Starting APU								
Preflight Data Entry Procedures								
IHADSS Bore-sight Procedures								
Doppler Program Procedures								
TADS Internal Bore-sight								
TADS Out-Front Bore-sight								
Extension, Employment, and Stowing of Cyclic								
Weapons Arming Procedures								
Select Appropriate Weapon System								
Direct View Optics (DVO) Operations								
Day Television (DTV) Operations								
Forward-Looking Infrared (FLIR) Operations								
Laser Spot Tracker Operations								
Image Auto Tracker Operations								
Laser Rangefinder/Designator Operations								
Target Store Procedures								
Emergency Procedure for Symbol Generator Failure								
Aircraft Position Update Function Procedures								
Target Tracking Using IHADSS								
IHADSS Operations								
Search For and Identify Targets With TADS								
Search, Acquire, Recognize, and Identify Targets With DTV								
Search, Acquire, Recognize, and Identify Targets With FLIR								
Search, Acquire, Recognize, and Identify Targets With DVO								
Target Tracking (TADS)								
Target Handover								
Operate Area Weapons System								
Engage Target With 30-mm Gun								
Operate Aerial Rocket Control System								
Engage Target With 2.75-Inch FFAR								
Engage Multiple Targets With Two Weapon Systems								
Point Target Weapon System Initialization								
Engage Target With Hellfire Missile								
Lock On Before Launch (LOBL) Autonomous Procedures								
LOBL Rapid-Fire Procedures								
LOBL Ripple-Fire Procedures								
Lock On After Launch (LOAL) Autonomous Procedures								
LOAL Remote Procedures								
LOAL Ripple-Fire Procedures								

**SECTION E: UTILITY OF VISUAL SCENE CONTENT
AND SPECIAL EFFECTS**

Instructions

In this section of the survey, you are asked to indicate which tasks trained in the AH-64 CWEPT utilize the **visual scene content** and **special effects** available. Enter a "Y" for those portions of the visual scene content or special effects that are used for training a task, and enter an "N" for those portions not used.

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (FRONT SEAT)

[illegible]

SECTION F: FIDELITY ADEQUACY OF DISPLAYS AND CONTROLS

Instructions

In this section of the survey, you are asked to rate the fidelity adequacy of the **displays** and **controls** for the tasks taught in the AH-64 CWEPT. Fidelity refers to how well the CWEPT displays and controls look like the AH-64's. Please use the following scale for your fidelity adequacy ratings. Rate each display and control for each task listed.

- A - Fidelity is adequate
- L - Less fidelity could be used
- M - More fidelity is required
- N/A - Not appropriate for this task

Record an "A" in the space provided to indicate that the display or control fidelity is considered adequate for training the task, an "L" to indicate that less fidelity could be used, or an "M" to indicate that more fidelity is required. If a display or control is not used, enter N/A. A separate page for displays and for controls is provided for your ratings.

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (FRONT SEAT)

	FUEL	ENGINE	FLIGHT	NAVIGATION	WEAPONS	COMMUNICATION
TASK						
Interior Check						
Before-Starting Auxiliary Power Unit (APU) Procedures						
After Starting APU						
Preflight Data Entry Procedures						
IHADSS Boresight Procedures						
Doppler Program Procedures						
TADS Internal Boresight						
TADS Out-Front Boresight						
Extension, Employment, and Stowing of Cyclic						
Weapons Arming Procedures						
Select Appropriate Weapon System						
Direct View Optics (DVO) Operations						
Day Television (DTV) Operations						
Forward-Looking Infrared (FIR) Operations						
Laser Spot Tracker Operations						
Image Auto Tracker Operations						
Laser Rangefinder/Designator Operations						
Target Store Procedures						
Emergency Procedure for Symbol Generator Failure						
Aircraft Position Update Function Procedures						
Target Tracking Using IHADSS						
HADSS Operations						
Search For and Identify Targets With TADS						
Search, Acquire, Recognize, and identify Targets With DTV						
Search, Acquire, Recognize, and identify Targets With FLIR						
Search, Acquire, Recognize, and identify Targets With DVO						
Target Tracking (TADS)						
Target Handover						
Operate Area Weapons System						
Engage Target With 30-mm Gun						
Operate Aerial Rocket Control System						
Engage Target With 2.75 Inch FFAR						
Identify Multiple Targets With Two Sides of the Display						
Mission Planning						
Crew Resource Management						
Threat Detection Procedures						
Self-Protection Procedures						
Emission Scrambling - Self Protection						
Electronic Countermeasures						
Radar Threat Identification						
JAL Radar Fire Procedures						

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (FRONT SEAT)

TASK	CONTROLS					
	FUEL	ENGINE	FLIGHT	NAVIGATION	WEAPONS	COMMUNICATION
Interior Check						
Before-Starting Auxiliary Power Unit (APU) Procedures						
After Starting APU						
Preflight Data Entry Procedures						
IHADSS Bore-sight Procedures						
Doppler Program Procedures						
TADS Internal Bore-sight						
TADS Out-Front Bore-sight						
Extension, Employment, and Stowing of Cyclic						
Weapons Arming Procedures						
Select Appropriate Weapon System						
Direct View Optics (DVO) Operations						
Day Television (DTV) Operations						
Forward-Looking Infrared (FLIR) Operations						
Laser Spot Tracker Operations						
Image Auto Tracker Operations						
Laser Rangefinder/Designator Operations						
Target Store Procedures						
Emergency Procedure for Symbol Generator Failure						
Aircraft Position Update Function Procedures						
Target Tracking Using IHADSS						
IHADSS Operations						
Search For and Identify Targets With TADS						
Search, Acquire, Recognize, and Identify Targets With DTV						
Search, Acquire, Recognize, and Identify Targets With FLIR						
Search, Acquire, Recognize, and Identify Targets With DVO						
Target Tracking (TADS)						
Target Handover						
Operate Area Weapons System						
Engage Target With 30-mm Gun						
Operate Aerial Rocket Control System						
Engage Target With 2.75 Inch FFAR						
Engage Multiple Targets With Two 2.75 Inch FFARs						
Engage Multiple Targets With Two 2.75 Inch FFARs						
Initialization						
Engage Target With Dual Launchers						
Engage Multiple Targets With Dual Launchers						
OBL Rapid Fire Procedures						
OBL Single Fire Procedures						
OBL On Air Launch (OAL) Autonomous Procedures						
OAL Rapid Fire Procedures						
OAL Single Fire Procedures						

SECTION G: FIDELITY ADEQUACY OF DISPLAY AND CONTROL INTERACTIONS

Instructions

In this section of the survey, you are asked to rate the fidelity adequacy of the **interactions** between the displays and controls for tasks trained in the AH-64 CWEPT. Here fidelity refers to how well the CWEPT displays and controls act and operate like the AH-64's. For each task listed please use the following scale to indicate your fidelity adequacy ratings of the interactions between the displays and controls for each subsystem.

- A - Fidelity is adequate
- L - Less fidelity could be used
- M - More fidelity is required
- N/A - Not appropriate for this task

Record an "A" in the space provided to indicate that the fidelity of the interactions of displays and controls is considered adequate for training the task, an "L" to indicate that less interaction fidelity is required, or an "M" to indicate that more interaction fidelity is required. Enter N/A if there is no interaction between displays and controls.

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (FRONT SEAT)

TASK	SUBSYSTEMS					
	FUEL	ENGINE	FLIGHT	NAVIGATION	WEAPONS	COMMUNICATION
Interior Check						
Before-Starting Auxiliary Power Unit (APU) Procedures						
After Starting APU						
Preflight Data Entry Procedures						
IHADSS Boresight Procedures						
Doppler Program Procedures						
TADS Internal Boresight						
TADS Out-Front Boresight						
Extension, Employment, and Stowing of Cyclic						
Weapons Arming Procedures						
Select Appropriate Weapon System						
Direct View Optics (DVO) Operations						
Day Television (DTV) Operations						
Forward-Looking Infrared (FLIR) Operations						
Laser Spot Tracker Operations						
Image Auto Tracker Operations						
Laser Rangefinder/Designator Operations						
Target Store Procedures						
Emergency Procedure for Symbol Generator Failure						
Aircraft Position Update Function Procedures						
Target Tracking Using IHADSS						
IHADSS Operations						
Search For and Identify Targets With TADS						
Search, Acquire, Recognize, and Identify Targets With DTV						
Search, Acquire, Recognize, and Identify Targets With FLIR						
Search, Acquire, Recognize, and Identify Targets With DVO						
Target Tracking (TADS)						
Target Handover						
Operate Area Weapons System						
Engage Target With 30-mm Gun						
Operate Aerial Rocket Control System						
Engage Target With 2.75-Inch FFAR						
Engage Multiple Targets With Two Weapons Systems						
Point-Target Weapon System Initialization						
Engage Target With Hellfire Missile (Lock-On Before Launch (LOBL) Autonomous Procedures						
LOBL Rapid Fire Procedures						
LOBL Rapid Fire Procedures						
Lock-On After Launch (LOAL) Autonomous Procedures						
LOAL Rapid Fire Procedures						
LOAL Rapid Fire Procedures						

AH-64 COCKPIT, WEAPONS AND EMERGENCY PROCEDURES TRAINER (CWEPT) SURVEY (BACK SEAT)

Introduction

The Army Research Institute is gathering data on the effectiveness of existing training devices. The purpose of this survey is to obtain information from subject matter experts on the effectiveness of training back seat operations in the AH-64 CWEPT.

The survey has been designed to obtain information about (a) the instructional features available on the CWEPT, and (b) how much the CWEPT sounds, looks, acts, and operates like the AH-64 when training specific tasks. The survey covers the following subject areas:

- personal data,
- overall effectiveness of instructional features,
- effectiveness of instructional features for specific tasks,
- fidelity adequacy of specific design features,
- utility of visual scene content and special effects,
- fidelity adequacy of displays and controls, and
- fidelity adequacy of display and control interactions.

You have been selected to complete this survey because of your expertise as a CWEPT instructor. Careful attention to the instructions and completion of all items is requested. The data from this survey will be used to aid training system designers in the future.

SECTION A: PERSONAL DATA

1. Enter your name and grade. (Note: This information will be used only in the event that it is necessary to contact you for further information.)

Name _____

Grade _____

2. Indicate below your present duty position(s)

_____ Instructor Pilot

_____ Simulator Instructor

_____ Simulator Operator

3. Check (✓) the helicopter(s) in which you are qualified and current or have been qualified (check as many as apply). In the space provided, write the number of hours you have logged in each helicopter.

	Qualified And Current	Qualified But Not Current	Hours Logged
UH-1	[]	[]	_____
UH-60	[]	[]	_____
OH-58	[]	[]	_____
OH-23	[]	[]	_____
OH-13	[]	[]	_____
OH-6	[]	[]	_____
CH-54	[]	[]	_____
CH-47	[]	[]	_____
AH-64	[]	[]	_____
AH-1	[]	[]	_____
TH-55	[]	[]	_____

4. Check (x) the training device(s) in which you are qualified and current as an instructor or have been qualified (check as many as apply).

	Qualified And Current	Qualified But Not Current
UH1FS	[]	[]
CH47FS	[]	[]
UH60FS	[]	[]
AH1FWS	[]	[]
AH-64 CMS	[]	[]
UH-1 CPT	[]	[]
AH-1 APT	[]	[]
AH-64 TSTT	[]	[]
AH-64 CWEPT	[]	[]
OH-58 CST	[]	[]
Other(s) (specify)		
_____	[]	[]
_____	[]	[]
_____	[]	[]

5. Indicate below the hours of training you have received on the instructional features of the training devices listed.

	Classroom Training	Device Hands-on Training
UH1FS	_____	_____
CH47FS	_____	_____
UH60FS	_____	_____
AH1FWS	_____	_____
AH-64 CMS	_____	_____
UH-1 CPT	_____	_____
AH-1 APT	_____	_____
AH-64 TSTT	_____	_____
AH-64 CWEPT	_____	_____
OH-58 CST	_____	_____

6. Indicate below the number of hours you have logged as pilot/copilot in the training devices listed below.

UH1FS	_____	hours
CH47FS	_____	hours
UH60FS	_____	hours
AH1FWS	_____	hours
AH-64 CMS	_____	hours
UH-1 CPT	_____	hours
AH-1 APT	_____	hours
AH-64 TSTT	_____	hours
AH-64 CWEPT	_____	hours
OH-58 CST	_____	hours

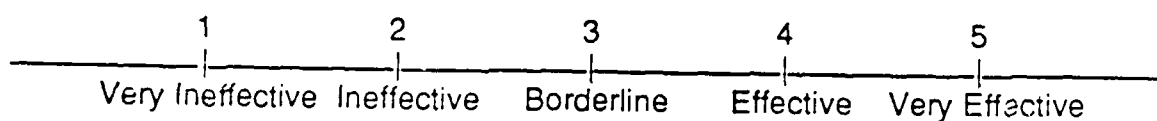
7. Indicate below the number of months you spent as an instructor on each of the following training devices.

UH1FS	_____	months
CH47FS	_____	months
UH60FS	_____	months
AH1FWS	_____	months
AH-64 CMS	_____	months
UH-1 CPT	_____	months
AH-1 APT	_____	months
AH-64 TSTT	_____	months
AH-64 CWEPT	_____	months
OH-58 CST	_____	months
Other(s) (specify)		
_____	_____	months
_____	_____	months
_____	_____	months

SECTION B: OVERALL EFFECTIVENESS OF INSTRUCTIONAL FEATURES

Instructions

The items listed below are designed to obtain information about the overall **effectiveness** of the instructional features on the AH-64 CWEPT. Read the definition of each instructional feature. In the space provided, place your rating of how effective the instructional feature is in providing training during CWEPT lessons. Use the scale provided to make your ratings.



INSTRUCTIONAL FEATURE DEFINITIONS

- **Hardcopy** - capability to "print out" selected displays and/or preprogrammed reports for briefing/debriefing and record keeping.
Overall Rating _____
- **Initial Conditions** - capability to preset the trainer to specific environmental conditions and to specific dynamic parameters.
Overall Rating _____
- **IOS Display** - provides the instructor with displays of current student performance during the training exercise. Overall Rating _____
- **Malfunction Insertion** - capability to insert simulated malfunctions manually or automatically into a training exercise.
Overall Rating _____
- **Parameter Freeze** - capability to freeze selected parameters during the training exercise.
Overall Rating _____
- **Performance Measure** - capability to calculate quantitative measures of student performance for use in assessing student progress and/or diagnosing student performance problems.
Overall Rating _____
- **Procedures Monitoring** - capability to monitor and document student performance and to display emergency procedures from a display instead of oral presentation.
Overall Rating _____

- **Scenario Control** - capability to configure the simulator/device so that events are controlled according to a specific scenario.

Overall Rating_____

- **System Freeze** - capability to temporarily halt the entire training exercise.

Overall Rating_____

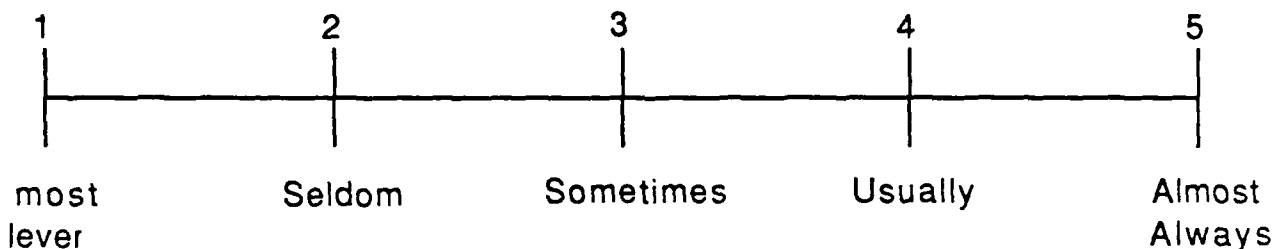
- **Variable Control** - capability to insert, remove, or change the simulator/device parameters during a training exercise.

Overall Rating_____

OVERALL USAGE OF INSTRUCTIONAL FEATURES

Instructions

The items below are designed to obtain information about the overall usage of the instructional features on the AH-64 CWEPT. Read the definition of each instructional feature. In the space provided, place your rating of how often you have used the instructional feature during UH-1 CPT lessons. Use the scale provided to make your ratings.



INSTRUCTIONAL FEATURE DEFINITIONS

Hardcopy - capability to "print out" selected displays and/or reprogrammed reports for briefing/debriefing and record keeping.

Overall Rating _____

Initial Conditions - capability to preset the trainer to a specific environmental condition and preset the dynamic parameters.

Overall Rating _____

IOS Display - provides the instructor with displays of current student performance during the training exercise.

Overall Rating _____

Malfunction Insertion - capability to insert simulated malfunctions manually or automatically into a training exercise.

Overall Rating _____

Parameter Freeze - capability to freeze selected parameters during the training exercise.

Overall Rating _____

- **Performance Measurement** - capability to calculate quantitative measures of student performance for use in assessing student progress and/or diagnose student performance problems.

Overall Rating _____

- **Procedures Monitoring** - capability to monitor and document student performance of specific normal and emergency procedures from a display instead of direct observation.

Overall Rating _____

- **Scenario Control** - capability to configure the simulator/device so that events are controlled according to a specific scenario.

Overall Rating _____

- **System Freeze** - capability to temporarily halt the entire training exercise.

Overall Rating _____

- **Variable Control** - capability to insert, remove, or change the simulator/device parameters during a training exercise.

Overall Rating _____

SECTION C: EFFECTIVENESS OF INSTRUCTIONAL FEATURES FOR SPECIFIC TASKS

Instructions

Listed on the following pages are the tasks taught in the AH-64 CWEPT. Using the scale provided below, rate the **effectiveness** of each instructional feature in **training the task**. Record your rating in the row for the task under the column representing the specific instructional feature. If the feature is not used for training a task, enter N/A. If you feel there is some other instructional feature that would be effective in training a specific task, please provide that information in the space provided at the end of the list of tasks.

SCALE FOR RATING THE EFFECTIVENESS OF INSTRUCTIONAL FEATURES FOR SPECIFIC TASKS

1	2	3	4	5	6	7
Unacceptable	Poor	Fair	Average	Good	Outstanding	Superior

H-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	INSTRUCTIONAL FEATURE				
	HARDCOPY	INITIAL CONDITIONS	IOS DISPLAY	MALFUNCTION INSERTION	PARAMETER FREEZE
Pre-Start Check					
Before-Starting Auxiliary Power Unit (APU) Procedures					
Starting APU Procedures					
After-Starting APU Procedures					
Before-Starting Engines					
Engine Start					
Engine Run-Up Procedures					
Engine Shutdown					
Engine Procedures for APU Fire					
Before-Taxi Checks					
Emergency Procedures (EP) for Engine Fire During Engine Start					
EP for Engine Fire in Flight					
EP for Electrical Fire in Flight					
EP for Smoke and Fume Elimination					
After-Landing Checks					
Engine Shutdown					
EP for NP Failed-Low					
EP for NP Failed-High					
Engine Restart in Flight					
EP for engine chip caution/warning light					
EP for Engine Failure					
EP for Engine Oil Filter Bypass Caution/Warning Light Illumination					
EP for Compressor Stall/Power Surge					
EP for Fuel System Malfunction					
Oil Management Procedures					
EP for Nose Gearbox Malfunction					
EP for Electrical System Malfunction					
EP for Overheated Battery					
EP for Main Transmission Malfunction					
EP for Intermediate and Tail Rotor gearbox Malfunction					
EP for Accessory Oil Pressure Caution/Warning Light Illumination					
EP for NR High					
EP for NR Low					
EP for Antitorque Malfunction					
EP for Hydraulic System Malfunction					
EP for Backup Control System Failure					
EP for ALE Caution/Warning Light Illumination					
EP for Rotor Brake Caution/Warning Light Illumination					
EP for Stabilator Malfunction					
EP for FWD Caution/Warning Light Illumination					
DSS Borelight Procedures					

UH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	INSTRUCTIONAL FEATURE				
	HARDCOPY	INITIAL CONDITIONS	IOS DISPLAY	MALFUNCTION INSERTION	PARAMETER FREEZE
NVS Operational Check					
Weapons Arming Procedures					
Operate Area Weapons System					
Area Rocket Control System (ARCS) Control Panel Initialization					
Operate ARCS					
Lock On After Launch Remote Designation Engagement Procedures					
Lock On Before Launch Rapid-Fire Engagement Procedures					

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	INSTRUCTIONAL FEATURE				
	PERFORMANCE MEASUREMENT	PROCEDURES MONITORING	SCENARIO CONTROL	SYSTEM FREEZE	VARIABLE CONTROL
Interior Check					
Before-Starting Auxiliary Power Unit (APU) Procedures					
Starting APU Procedures					
After-Starting APU Procedures					
Before-Starting Engines					
Engine Start					
Engine Run-Up Procedures					
Engine Shutdown					
Engine Procedures for APU Fire					
Before-Taxi Checks					
Emergency Procedures (EP) for Engine Fire During Engine Start					
EP for Engine Fire in Flight					
EP for Electrical Fire in Flight					
EP for Smoke and Fume Elimination					
After-Landing Checks					
Engine Shutdown					
EP for NP Failed-Low					
EP for NP Failed-High					
Engine Restart in Flight					
EP for engine chip caution/warning light					
EP for Engine Failure					
EP for Engine Oil Filter Bypass Caution/Warning Light Illumination					
EP for Compressor Stall/Power Surge					
EP for Fuel System Malfunction					
Fuel Management Procedures					
EP for Nose Gearbox Malfunction					
EP for Electrical System Malfunction					
EP for Overheated Battery					
EP for Main Transmission Malfunction					
EP for Intermediate and Tail Rotor Gearbox Malfunction					
EP for Accessory Oil Pressure Caution/Warning Light Illumination					
EP for Hydraulic Malfunction					
EP for Landing Gear Malfunction					
EP for Antenna Malfunction					
EP for Hydraulic System Malfunction					
EP for Fuel System Malfunction					
EP for Aut. Caution/Warning Light Illumination					
EP for Fuel System Caution/Warning Light Illumination					
EP for Subalar Malfunction					
EP for Cab Caution/Warning Light Illumination					
IHADSS Foresight Procedures					

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	INSTRUCTIONAL FEATURE				
	PERFORMANCE MEASUREMENT	PROCEDURES MONITORING	SCENARIO CONTROL	SYSTEM FREEZE	VARIABLE CONTROL
PNVS Operational Check					
Weapons Arming Procedures					
Operate Area Weapons System					
Aerial Rocket Control System (ARCS) Control Panel Initialization					
Operate ARCS					
Lock On After Launch Remote Designation Engagement Procedures					
Lock On Before Launch Rapid-Fire Engagement Procedures					

In the space below, please provide information if you feel there is some other instructional feature that would be effective in training a specific task. For each comment, list the specific task followed by the suggested instructional feature.

Specific Task

Instructional Feature

SECTION D: FIDELITY ADEQUACY OF SPECIFIC DESIGN FEATURES

Instructions

In this section of the survey, you are asked to rate the fidelity adequacy of the training device's **design features** for the tasks taught in the AH-64 CWEPT. Fidelity refers to how well the CWEPT sounds, looks, feels, acts, and operates like the AH-64. Please use the following scale to indicate your fidelity adequacy ratings. Rate each design feature for each task listed.

- A - Fidelity is adequate
- L - Less fidelity could be used
- M - More fidelity is required
- N/A - Not appropriate for this task

Record an "A" in the space provided to indicate that the design feature's fidelity is considered adequate for training the task, an "L" to indicate that less fidelity could be used, or an "M" to indicate that more fidelity is required. If the design feature is not used for training the task, enter N/A.

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	DESIGN FEATURE		
	SOUND EFFECTS	VISUAL IMAGE OF VDU	SIZE OF GAMING AREA
Interior Check			
Before-Starting Auxiliary Power Unit (APU) Procedures			
Starting APU Procedures			
After-Starting APU Procedures			
Before-Starting Engines			
Engine Start			
Engine Run-Up Procedures			
Engine Shutdown			
Engine Procedures for APU Fire			
Before-Taxi Checks			
Emergency Procedures (EP) for Engine Fire During Engine Start			
EP for Engine Fire in Flight			
EP for Electrical Fire in Flight			
EP for Smoke and Fume Elimination			
After-Landing Checks			
Engine Shutdown			
EP for NP Failed-Low			
EP for NP Failed-High			
Engine Restart in Flight			
EP for engine chip caution/warning light			
EP for Engine Failure			
EP for Engine Oil Filter Bypass Caution/Warning Light Illumination			
EP for Compressor Stall/Power Surge			
EP for Fuel System Malfunction			
Fuel Management Procedures			
EP for Nose Gearbox Malfunction			
EP for Electrical System Malfunction			
EP for Overheated Battery			
EP for Main Transmission Malfunction			
EP for Intermediate and Tail Rotor Gearbox Malfunction			
EP for Accessory Oil Pressure Caution/Warning Light Illumination			
EP for NP High			
EP for NP Low			
EP for Antitorque Malfunction			
EP for Hydraulic System Malfunction			
EP for Backup Control System Failure			
EP for ASE Caution/Warning Light Illumination			
EP for Tail Brake Caution/Warning Light Illumination			
EP for Stabilator Malfunction			
EP for ECG Caution/Warning Light Illumination			
IHAOSS Bore-sight Procedures			

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	DESIGN FEATURE		
	SOUND EFFECTS	VISUAL IMAGE OF HEADS OUT	SIZE OF GAMING AREA
PNVS Operational Check			
Weapons Arming Procedures			
Operate Area Weapons System			
Aerial Rocket Control System (ARCS)			
Control Panel Initialization			
Operate ARCS			
Lock On After Launch Remote			
Designation Engagement Procedures			
Lock On Before Launch Rapid-Fire			
Engagement Procedures			

SECTION E: UTILITY OF VISUAL SCENE CONTENT AND SPECIAL EFFECTS

Instructions

In this section of the survey, you are asked to indicate which tasks trained in the AH-64 CWEPT utilize the **visual scene content** and **special effects** available. Enter a "Y" for those portions of the visual scene content or special effects that are used for training a task, and enter an "N" for those portions not used.

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	VISUAL SCENE CONTENT							SPECIAL EFFECTS		
	TREES	MOUNTAINS	BUILDINGS	SHEDS	TANKS	POWERLINE TOWER	WATER TOWER	TRACERS	ORDNANCE IMPACT	DUST
Interior Check										
Before-Starting Auxiliary Power Unit (APU) Procedures										
Starting APU Procedures										
After-Starting APU Procedures										
Before-Starting Engines										
Engine Start										
Engine Run-Up Procedures										
Engine Shutdown										
Engine Procedures for APU Fire										
Before-Taxi Checks										
Emergency Procedures (EP) for Engine Fire During Engine Start										
EP for Engine Fire in Flight										
EP for Electrical Fire in Flight										
EP for Smoke and Fume Elimination										
After-Landing Checks										
Engine Shutdown										
EP for NP Failed-Low										
EP for NP Failed-High										
Engine Restart in Flight										
EP for engine chip caution/warning light										
EP for Engine Failure										
EP for Engine Oil Filter Bypass Caution/Warning Light Illumination										
EP for Compressor Stall/Power Surge										
EP for Fuel System Malfunction										
Fuel Management Procedures										
EP for Nose Gearbox Malfunction										
EP for Electrical System Malfunction										
EP for Overheated Battery										
EP for Main Transmission Malfunction										
EP for Intermediate and Tail Rotor gearbox Malfunction										
EP for Accessory Oil Pressure Caution/Warning Light Illumination										
EP for Fuel High										
EP for Fuel Low										
EP for Antitorque Malfunction										
EP for Hydraulic System Malfunction										
EP for Backup Control System Failure										
EP for ASE Caution/Warning Light Illumination										
EP for Main Brake Caution/Warning Light Illumination										
EP for Stabilator Malfunction										
EP for Fuel Caution/Warning Light Illumination										
ADSS Bore-sight Procedures										

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	VISUAL SCENE CONTENT							SPECIAL EFFECTS		
	TREES	MOUNTAINS	BUILDINGS	SHEDS	TANKS	POWERLINE TOWER	WATER TOWER	TRACERS	ORDNANCE IMPACT	DUST
PNVS Operational Check										
Weapons Arming Procedures										
Operate Area Weapons System										
Aerial Rocket Control System (ARCS)										
Control Panel Initialization										
Operate ARCS										
Lock On After Launch Remote										
Designation Engagement Procedures										
Lock On Before Launch Rapid-Fire										
Engagement Procedures										

SECTION F: FIDELITY ADEQUACY OF DISPLAYS AND CONTROLS

Instructions

In this section of the survey, you are asked to rate the fidelity adequacy of the **displays** and **controls** for the tasks taught in the AH-64 CWEPT. Fidelity refers to how well the CWEPT displays and controls look like the AH-64's. Please use the following scale for your fidelity adequacy ratings. Rate each display and control for each task listed.

- A - Fidelity is adequate
- L - Less fidelity could be used
- M - More fidelity is required
- N/A - Not appropriate for this task

Record an "A" in the space provided to indicate that the display or control fidelity is considered adequate for training the task, an "L" to indicate that less fidelity could be used, or an "M" to indicate that more fidelity is required. If a display or control is not used, enter N/A. A separate page for displays and for controls is provided for your ratings.

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	CONTROLS					
	FUEL	ENGINE	FLIGHT	NAVIGATION	WEAPONS	COMMUNICATION
Interior Check						
Before-Starting Auxiliary Power Unit (APU) Procedures						
Starting APU Procedures						
After-Starting APU Procedures						
Before-Starting Engines						
Engine Start						
Engine Run-Up Procedures						
Engine Shutdown						
Engine Procedures for APU Fire						
Before-Taxi Checks						
Emergency Procedures (EP) for Engine Fire During Engine Start						
EP for Engine Fire in Flight						
EP for Electrical Fire in Flight						
EP for Smoke and Fume Elimination						
After-Landing Checks						
Engine Shutdown						
EP for NP Failed-Low						
EP for NP Failed-High						
Engine Restart in Flight						
EP for Engine Chip Caution/Warning Light						
EP for Engine Failure						
EP for Engine Oil Filter Bypass Caution/Warning Light Illumination						
EP for Compressor Stall/Power Surge						
EP for Fuel System Malfunction						
Fuel Management Procedures						
EP for Nose Gearbox Malfunction						
EP for Electrical System Malfunction						
EP for Overheated Battery						
EP for Main Transmission Malfunction						
EP for Intermediate and Tail Rotor Gearbox Malfunction						
EP for Accessory Oil Pressure Caution/Warning Light Illumination						
EP for NR High						
EP for NR Low						
EP for Antitorque Malfunction						
EP for Hydraulic System Malfunction						
EP for Backup Control System Failure						
EP for Aft Caution/Warning Light Illumination						
EP for Rotor Brake Caution/Warning Light Illumination						
EP for Stabilator Malfunction						
EP for ECS Caution/Warning Light Illumination						
ADSS Boreight Procedures						

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	CONTROLS					COMMUNICATION
	FUEL	ENGINE	FLIGHT	NAVIGATION	WEAPONS	
PNVS Operational Check						
Weapons Arming Procedures						
Operate Area Weapons System						
Aerial Rocket Control System (ARCS) Control Panel Initialization						
Operate ARCS						
Lock On After Launch Remote Designation Engagement Procedures						
Lock On Before Launch Rapid-Fire Engagement Procedures						

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	DISPLAYS					
	FUEL	ENGINE	FLIGHT	NAVIGATION	WEAPONS	COMMUNICATION
Interior Check						
Before-Starting Auxiliary Power Unit (APU) Procedures						
Starting APU Procedures						
After-Starting APU Procedures						
Before-Starting Engines						
Engine Start						
Engine Run-Up Procedures						
Engine Shutdown						
Engine Procedures for APU Fire						
Before-Taxi Checks						
Emergency Procedures (EP) for Engine Fire During Engine Start						
EP for Engine Fire in Flight						
EP for Electrical Fire in Flight						
EP for Smoke and Fume Elimination						
After-Landing Checks						
Engine Shutdown						
EP for NP Failed-Low						
EP for NP Failed-High						
Engine Restart in Flight						
EP for Engine Chip Caution/Warning Light						
EP for Engine Failure						
EP for Engine Oil Filter Bypass Caution/Warning Light Illumination						
EP for Compressor Stall/Power Surge						
EP for Fuel System Malfunction						
Fuel Management Procedures						
EP for Nose Gearbox Malfunction						
EP for Electrical System Malfunction						
EP for Overheated Battery						
EP for Main Transmission Malfunction						
EP for Intermediate and Tail Rotor Gearbox Malfunction						
EP for Accessory Oil Pressure Caution/Warning Light Illumination						
EP for NR High						
EP for NR Low						
EP for Antitorque Malfunction						
EP for Hydraulic System Malfunction						
EP for Backup Control System Failure						
EP for ASE Caution/Warning Light Illumination						
EP for Rotor Brake Caution/Warning Light Illumination						
EP for Stabilator Malfunction						
EP for ECS Caution/Warning Light Illumination						
THADSS Boreight Procedures						

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	DISPLAYS					
	FUEL	ENGINE	FIGHT	NAVIGATION	WEAPONS	COMMUNICATION
PNVS Operational Check						
Weapons Arming Procedures						
Operate Area Weapons System						
Aerial Rocket Control System (ARCS) Control Panel Initialization						
Operate ARCS						
Lock On After Launch Remote Designation Engagement Procedures						
Lock On Before Launch Rapid-Fire Engagement Procedures						

SECTION G: FIDELITY ADEQUACY OF DISPLAY AND CONTROL INTERACTIONS

Instructions

In this section of the survey, you are asked to rate the fidelity adequacy of the **interactions** between the displays and controls for tasks trained in the AH-64 CWEPT. Here fidelity refers to how well the CWEPT displays and controls act and operate like the AH-64's. For each task listed please use the following scale to indicate your fidelity adequacy ratings of the interactions between the displays and controls for each subsystem.

- A - Fidelity is adequate
- L - Less fidelity could be used
- M - More fidelity is required
- N/A - Not appropriate for this task

Record an "A" in the space provided to indicate that the fidelity of the interactions of displays and controls is considered adequate for training the task, an "L" to indicate that less interaction fidelity is required, or an "M" to indicate that more interaction fidelity is required. Enter N/A if there is no interaction between displays and controls.

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	SUBSYSTEMS					
	FUEL	ENGINE	FLIGHT	NAVIGATION	WEAPONS	COMMUNICATION
Interior Check						
Before-Starting Auxiliary Power Unit (APU) Procedures						
Starting APU Procedures						
After-Starting APU Procedures						
Before-Starting Engines						
Engine Start						
Engine Run-Up Procedures						
Engine Shutdown						
Engine Procedures for APU Fire						
Before-Taxi Checks						
Emergency Procedures (EP) for Engine Fire During Engine Start						
EP for Engine Fire in Flight						
EP for Electrical Fire in Flight						
EP for Smoke and Fume Elimination						
After-Landing Checks						
Engine Shutdown						
EP for NP Failed-Low						
EP for NP Failed-High						
Engine Restart in Flight						
EP for engine chip caution/warning light						
EP for Engine Failure						
EP for Engine Oil Filter Bypass Caution/Warning Light Illumination						
EP for Compressor Stall/Power Surge						
EP for Fuel System Malfunction						
Fuel Management Procedures						
EP for Nose Gearbox Malfunction						
EP for Electrical System Malfunction						
EP for Overheated Battery						
EP for Main Transmission Malfunction						
EP for Intermediate and Tail Rotor Gearbox Malfunction						
EP for Accessory Oil Pressure Caution/Warning Light Illumination						
EP for NR High						
EP for NR Low						
EP for Antitorque Malfunction						
EP for Hydraulic System Malfunction						
EP for Backup Control System Failure						
EP for ASL Caution/Warning Light Illumination						
EP for Rotor Brake Caution/Warning Light Illumination						
EP for Stabilator Malfunction						
EP for ECS Caution/Warning Light Illumination						
HADSS Bore-sight Procedures						

AH-64 COCKPIT, WEAPONS, AND EMERGENCY PROCEDURE TRAINER (BACK SEAT)

TASK	SUBSYSTEMS					
	FUEL	ENGINE	FLIGHT	NAVIGATION	WEAPONS	COMMUNICATION
PNVS Operational Check						
Weapons Arming Procedures						
Operate Area Weapons System						
Aerial Rocket Control System (ARCS) Control Panel Initialization						
Operate ARCS						
Lock On After Launch Remote Designation Engagement Procedures						
Lock On Before Launch Rapid-Fire Engagement Procedures						

APPENDIX F
MASTERFILE DESCRIPTION
OF OSBATS


```

$ INTEGRATED OSBATS DATA FILE
$ FINAL: 5/27/88 - PRABIR GUHA
FILENAME=TOT, SUFFIX=FOC, $

$ DOMAIN SEGMENT
  SEGNAME=DOMAIN, SEGTYPE=S1, $
  FIELDNAME=DOM_NM, ALIAS=DN, FORMAT=A15, $

$ !! TASK DATA !!
  SEGNAME=TASK, SEGTYPE=S1, PARENT=DOMAIN, $
$ \HUMRRO\DATA\TASKDATA.INP
  FIELDNAME=ATM, ALIAS=AN, FORMAT=I4, $
  FIELDNAME=NAME, ALIAS=TN, FORMAT=A12, $
$ \HUMRRO\DATA\LONGDISC.INP
  FIELDNAME=LONG_NAME, ALIAS=LN, FORMAT=A40, $
$ \HUMRRO\DATA\SIMDET.INP
  FIELDNAME=RQABS, ALIAS=RA, FORMAT=I1, $
  FIELDNAME=RQSPEC1, ALIAS=RS1, FORMAT=I1, $
  FIELDNAME=RQSPEC2, ALIAS=RS2, FORMAT=I1, $
  FIELDNAME=RQSPEC3, ALIAS=RS3, FORMAT=I1, $
  FIELDNAME=RQTNG1, ALIAS=RT1, FORMAT=I1, $
  FIELDNAME=RQTNG2, ALIAS=RT2, FORMAT=I1, $
$ \HUMRRO\DATA\LPOINTS.INP
  FIELDNAME=TENTRY, ALIAS=, FORMAT=F8.4, $
  FIELDNAME=TSTD, ALIAS=, FORMAT=F4.2, $
$ \HUMRRO\DATA\EQPHRS.INP
  FIELDNAME=CLASS, ALIAS=, FORMAT=F9.2, $
  FIELDNAME=NOFLT, ALIAS=, FORMAT=F9.2, $
  FIELDNAME=FLT, ALIAS=, FORMAT=F9.2, $
  FIELDNAME=SETUP, ALIAS=, FORMAT=F9.2, $
  FIELDNAME=OTHERS, ALIAS=, FORMAT=F9.2, $

  SEGNAME=INSTFT, SEGTYPE=S1, PARENT=TASK, $
$ TASK-INSTRUCTIONAL FEATURE LINK FIELD
  FIELDNAME=IF_NM, ALIAS=, FORMAT=A20, $
$ \HUMRRO\DATA\TABLE9.INP
  FIELDNAME=IF_NM_T9, ALIAS=X, FORMAT=I1, $

  SEGNAME=FD_SD, SEGTYPE=S1, PARENT=TASK, $
$ TASK-FIDELITY DIMENSION LINK FIELD
  FIELDNAME=FD_NM, ALIAS=, FORMAT=A14, $
$ \HUMRRO\DATA\CUERSP.INP
  FIELDNAME=FD_NM_CR, ALIAS=, FORMAT=F6.2, $

$ !! DEVICE DATA !!
  SEGNAME=DEVICE, SEGTYPE=S1, PARENT=DOMAIN, $
$ \HUMRRO\DATA\DEV_NAME.INP
  FIELDNAME=DEV_NAME, ALIAS=, FORMAT=A20, $
$ \HUMRRO\DATA\DEV_CST.INP
  FIELDNAME=INVEST, ALIAS=, FORMAT=F9.1, $
  FIELDNAME=FIXED_YR, ALIAS=, FORMAT=F9.1, $
  FIELDNAME=VAR_YR, ALIAS=, FORMAT=F9.4, $
  FIELDNAME=LC, ALIAS=, FORMAT=I6, $
  FIELDNAME=UTL, ALIAS=, FORMAT=F9.1, $
$ \HUMRRO\DATA\LONGDEV.INP
  FIELDNAME=LNG, ALIAS=, FORMAT=A40, $

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```

    SEGNAME=DEVIN, SEGTYPE=S1, PARENT=DEVICE, $
$ DEVICE-INSTRUCTIONAL FEATURE LINK FIELD
    FIELDNAME=DIF_NM, ALIAS=, FORMAT=A20, $
$ \HUMRRO\DATA\DEV_IF.INP
    FIELDNAME=DEVIF, ALIAS=, FORMAT=I1, $

    SEGNAME=DEVFD, SEGTYPE=S1, PARENT=DEVICE, $
$ DEVICE-FIDELITY DIMENSION LINK FIELD
    FIELDNAME=DFD_NM, ALIAS=, FORMAT=A14, $
$ \HUMRRO\DATA\DEVFID.INP
    FIELDNAME=DEVFID, ALIAS=, FORMAT=F6.2, $

$ !! INSTRUCTIONAL FEATURE DATA !!
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$ \HUMRRO\DATA\IF_NAME.INP
    FIELDNAME=IF_NAME, ALIAS=, FORMAT=A20, FIELDTYPE=I, $
    FIELDNAME=BEN_WT, ALIAS=, FORMAT=F6.2, $
    FIELDNAME=COSTIF, ALIAS=, FORMAT=F9.1, $
$ \HUMRRO\DATA\LONGIF.INP
    FIELDNAME=LONGIF, ALIAS=, FORMAT=A40, $

$ !! FIDELITY DIMENSION DATA !!
    SEGNAME=FD_TR, SEGTYPE=S1, PARENT=DOMAIN, $
$ \HUMRRO\DATA\FDIMENS.INP
    FIELDNAME=FD_NAME, ALIAS=, FORMAT=A14, FIELDTYPE=I, $
$ \HUMRRO\DATA\TECH.INP
    FIELDNAME=TECH1, ALIAS=TH1, FORMAT=F9.2, $
    FIELDNAME=TECH2, ALIAS=TH2, FORMAT=F9.2, $
    FIELDNAME=TECH3, ALIAS=TH3, FORMAT=F9.2, $
    FIELDNAME=TECH4, ALIAS=TH4, FORMAT=F9.2, $
    FIELDNAME=TECH5, ALIAS=TH5, FORMAT=F9.2, $
    FIELDNAME=TECH6, ALIAS=TH6, FORMAT=F9.2, $
    FIELDNAME=TECH7, ALIAS=TH7, FORMAT=F9.2, $
$ \HUMRRO\DATA\MINMAX.INP
    FIELDNAME=FMIN, ALIAS=, FORMAT=F9.1, $
    FIELDNAME=FMAX, ALIAS=, FORMAT=F9.1, $
    FIELDNAME=XP, ALIAS=, FORMAT=F9.1, $
    FIELDNAME=FFMIN, ALIAS=, FORMAT=F9.1, $
$ \HUMRRO\DATA\DIMDESC.INP
    FIELDNAME=FD_DISC, ALIAS=, FORMAT=A60, $

$ !! STUDENT DATA !!
    SEGNAME=STUDENT, SEGTYPE=U, PARENT=DOMAIN, $
$ \HUMRRO\DATA\SENVARS.INP
    FIELDNAME=LC_MUL, ALIAS=, FORMAT=F9.2, $
    FIELDNAME=STUDENTS, ALIAS=, FORMAT=I5, $
    FIELDNAME=N_MAX, ALIAS=, FORMAT=F9.2, $
    FIELDNAME=F_MAX, ALIAS=, FORMAT=F9.2, $
    FIELDNAME=UTIL_MUL, ALIAS=, FORMAT=F9.2, $
    FIELDNAME=FXD_MUL, ALIAS=, FORMAT=F9.2, $
    FIELDNAME=VAR_MUL, ALIAS=, FORMAT=F9.2, $
    FIELDNAME=STD_MUL, ALIAS=, FORMAT=F9.2, $
    FIELDNAME=PAYBK, ALIAS=, FORMAT=F9.2, $

END
DBA=, $

```

APPENDIX G
OSBATS DATAFILE STRUCTURE

<simdet.inp>
 rqabs - integer
 rspec1 - integer
 rspec2 - integer
 rspec3 - integer
 rqtng1 - integer
 rqtng2 - integer

<techperf.inp>
 tech - floating point

<minmax.inp>
 min - floating point
 max - floating point
 xp - floating point
 fmin - floating point

<lpoints.inp>
 tentry - floating point
 tstd - floating point

<eqphrs.inp>
 class - floating point
 nonflt - floating point
 flt - floating point
 setup - floating point
 other - floating point

<longdisc.inp>
 tasks_lng - 40 characters

<longif.inp>
 inf_lng - 40 characters

<longdev.inp>
 devices_lng - 40 characters

<taskdata.inp>
 tasks_atm - integer
 tasks_name - 16 characters

<dimdesc.inp>
 xxx - 40 characters

<if_name.inp>
 inf_name - 12 characters
 inf_ben_wt - floating point
 inf_cost - floating point

<fdimens.inp>
 fiddims_name - 40 characters

<tech.inp>
 fiddims_1_tp - floating point
 fiddims_2_tp - floating point
 fiddims_3_tp - floating point
 fiddims_4_tp - floating point
 fiddims_5_tp - floating point
 fiddims_6_tp - floating point
 fiddims_7_tp - floating point

<devfid.inp>
 DEVFID_1 - floating point
 DEVFID_2 - floating point
 DEVFID_3 - floating point
 DEVFID_4 - floating point
 DEVFID_5 - floating point
 DEVFID_6 - floating point
 DEVFID_7 - floating point
 DEVFID_8 - floating point
 DEVFID_9 - floating point
 DEVFID_10 - floating point
 DEVFID_11 - floating point

<dev_cst.inp>
 dev_invest - floating point
 dev_fixed_yr - floating point
 dev_var_yr - floating point
 dev_lc - integer
 dev_util - floating point

<dev_name.inp>
 dev_name - 20 characters

<senvars.inp>
 LC - floating point
 STUD - floating point
 NMX - floating point
 FMX - floating point
 U_MUL - floating point
 F_MUL - floating point
 V_MUL - floating point
 S_MUL - floating point
 PYBK - floating point